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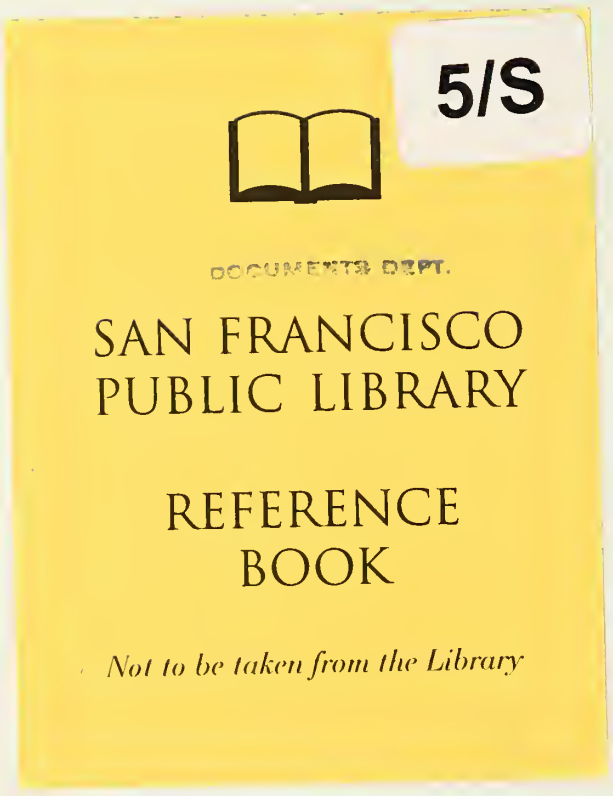

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CALTRAIN SAN FRANCISCO
DOWNTOWN EXTENSION PROJECT
CONCEPTUAL DESIGN AND DRAFT EIS/EIR

CalTrain Railroad Operations Analysis Report

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1. INTRODUCTION

1.1 Purpose

This report documents the methodology and results of the operations analysis of a new Peninsula Commute Service (CalTrain) commuter rail terminal station in downtown San Francisco. The evaluation is part of an overall review of environmental impacts, costs, and benefits associated with alternatives for extending CalTrain from its present northern terminus station at Fourth and Townsend Streets to a proposed new location in downtown San Francisco at the current Transbay Terminal site.

1.2 Project Area and Description

Figure 1 depicts the project area south of Market Street in San Francisco. It illustrates the current CalTrain terminal at Fourth and Townsend Streets, the proposed station at the Transbay Terminal site, located between Mission and Howard Streets and between First and Beale Streets, and the connecting alignment options.

The proposed project consists of two alternatives, the No-Build Alternative and the Transbay Terminal Site Alternative. The No-Build Alternative represents the existing and committed (funded) transportation services and facilities in the project area. This includes existing CalTrain service and funded improvements; related bus, rail, and roadway improvements in the project area; and a BART extension (partially funded) to the San Francisco International Airport.

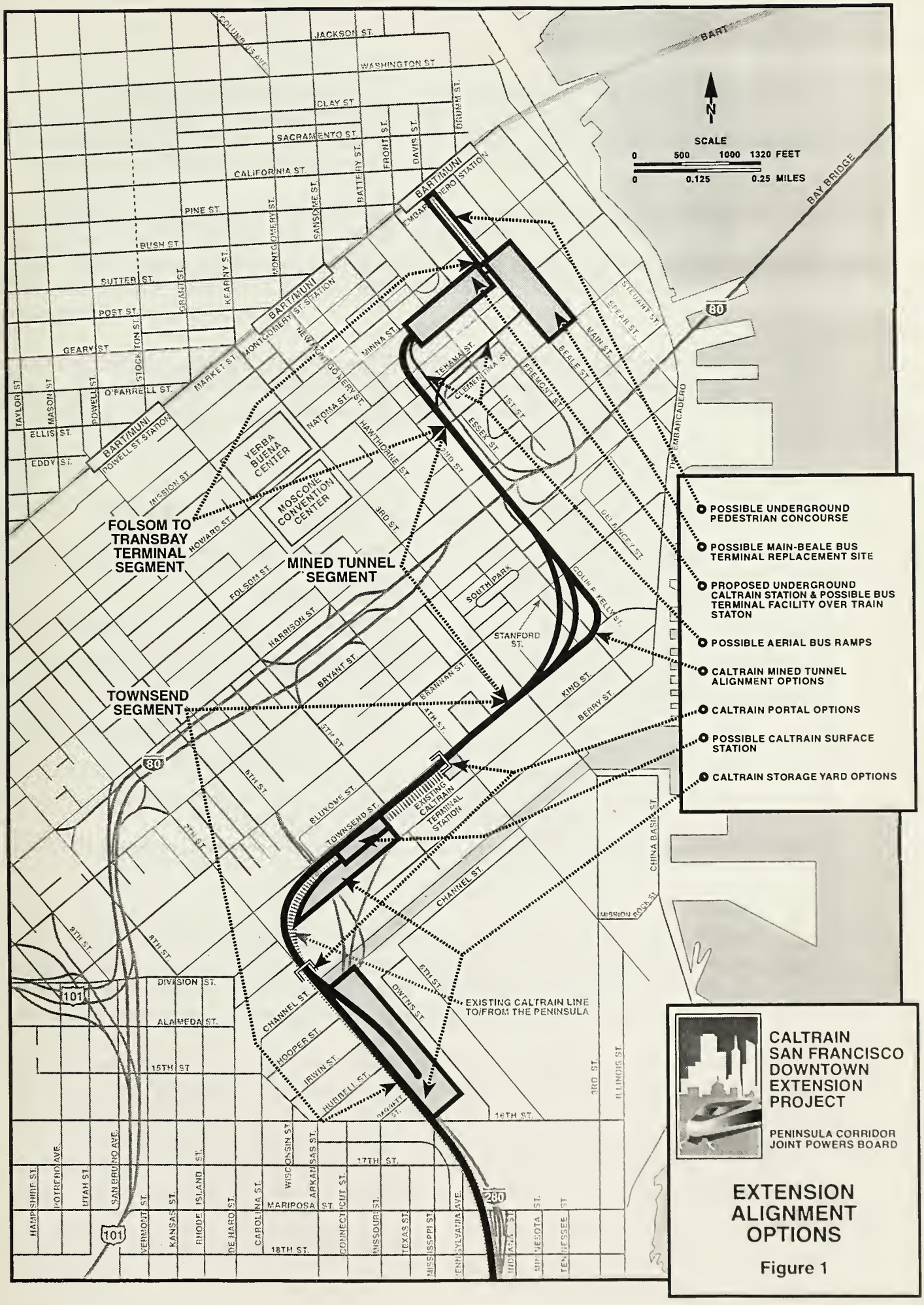
The Transbay Terminal Site Alternative is the proposed "build" alternative for extending CalTrain from its current terminal at Fourth and Townsend Streets to downtown San Francisco. The build alternative incorporates all of the elements described in the No-Build Alternative except for those transportation services or facilities that would be replaced or discontinued as result of construction and implementation of the Transbay Terminal Site Alternative. In addition, this alternative includes the following elements:

1. The underground rail extension and a new terminal facility at the existing Transbay Terminal site in downtown San Francisco;

2. The propulsion system for operating CalTrain in subway and along the length of the alignment;

3. Expanded park-and-ride lots at 15 station locations; and

4. A new CalTrain storage yard at either Sixteenth and Owens Streets or along Townsend Street.



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EXTENSION ALIGNMENT OPTIONS

Figure 1

1.2.1 Underground Rail Extension. The CalTrain Downtown Extension Alignment extends from the vicinity of the current terminal into a tunnel that, with options, generally follows Townsend, Colin P. Kelly, and Essex Streets to the Transbay Terminal Site (Figure 1). The alignment connects with the existing track along Seventh Street south of Townsend Street.

The alignment has three options that differ in where the track goes underground and in its orientation along Townsend Street. Table 1 summarizes the Townsend Street alignment options. In all options, the existing terminal and track at Fourth and Townsend Streets would be removed. Two of the options would provide a new surface station for Mission Bay on Townsend Street between Fifth and Sixth Streets.

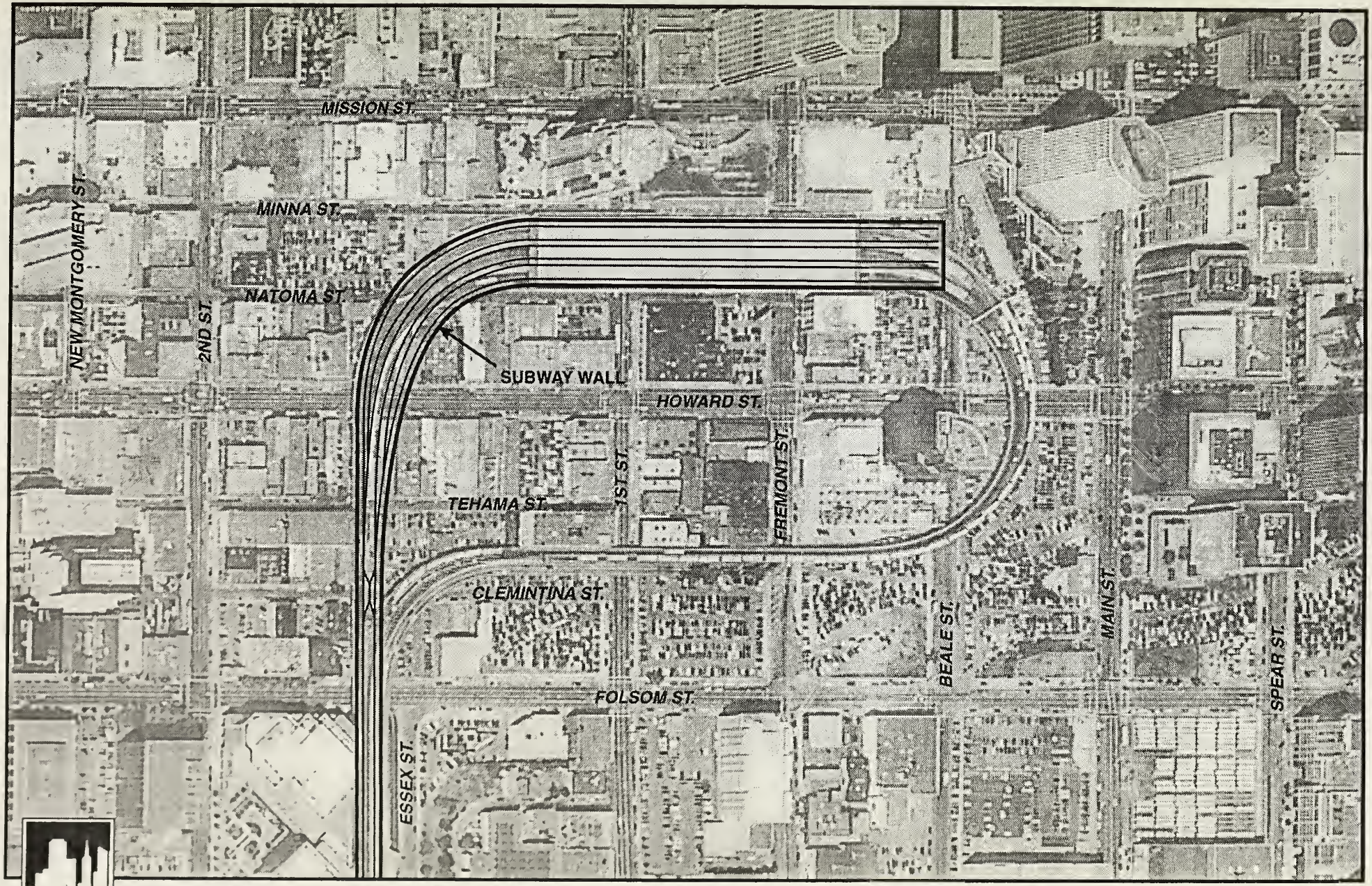
There are also three options on the radius of the tunnel in its turn from Townsend Street to Colin P. Kelly Street: a short-radius tunnel with a 30-mph speed limit, a medium-radius tunnel with a 20-mph speed limit, and a long-radius tunnel with a 50-mph speed limit.

TABLE 1. TOWNSEND STREET ALIGNMENT OPTIONS

	OPTION		
Characteristic	**A**	**B**	**C**
Alignment along Townsend	Median (Widened Street)	South Side	Subway, South Side
Tunnel Portal	Fourth Street	Fourth Street	Seventh/Berry Streets
Mission Bay Station	Yes	Yes	No
Mission Bay Station Tracks	2	3	N/A
Third Track to 16th St. Yard	Yes	Yes	No
Cost	+$10 million	Base	+$100 million

1.2.2 New Terminal Facility. The new underground CalTrain terminal would require demolition of the existing Transbay Terminal, which would be replaced as a project mitigation. The Transbay Terminal, which is currently used by buses, was originally built in 1938 for interurban electric trains operating from the East Bay over the Bay Bridge.

The new underground station would encompass the existing Transbay Terminal footprint and part of the width of Natoma Street, which parallels the site immediately to the south. Six tracks and three center platforms, each 850 feet long and 28 feet wide, would serve CalTrain and future high-speed rail passengers. Each platform would have escalators and stair access to the street level. Preliminary Transbay Terminal track and platform configurations are shown in Figure 2. Figure 3 depicts a preliminary architectural plan and elevation of the underground station.



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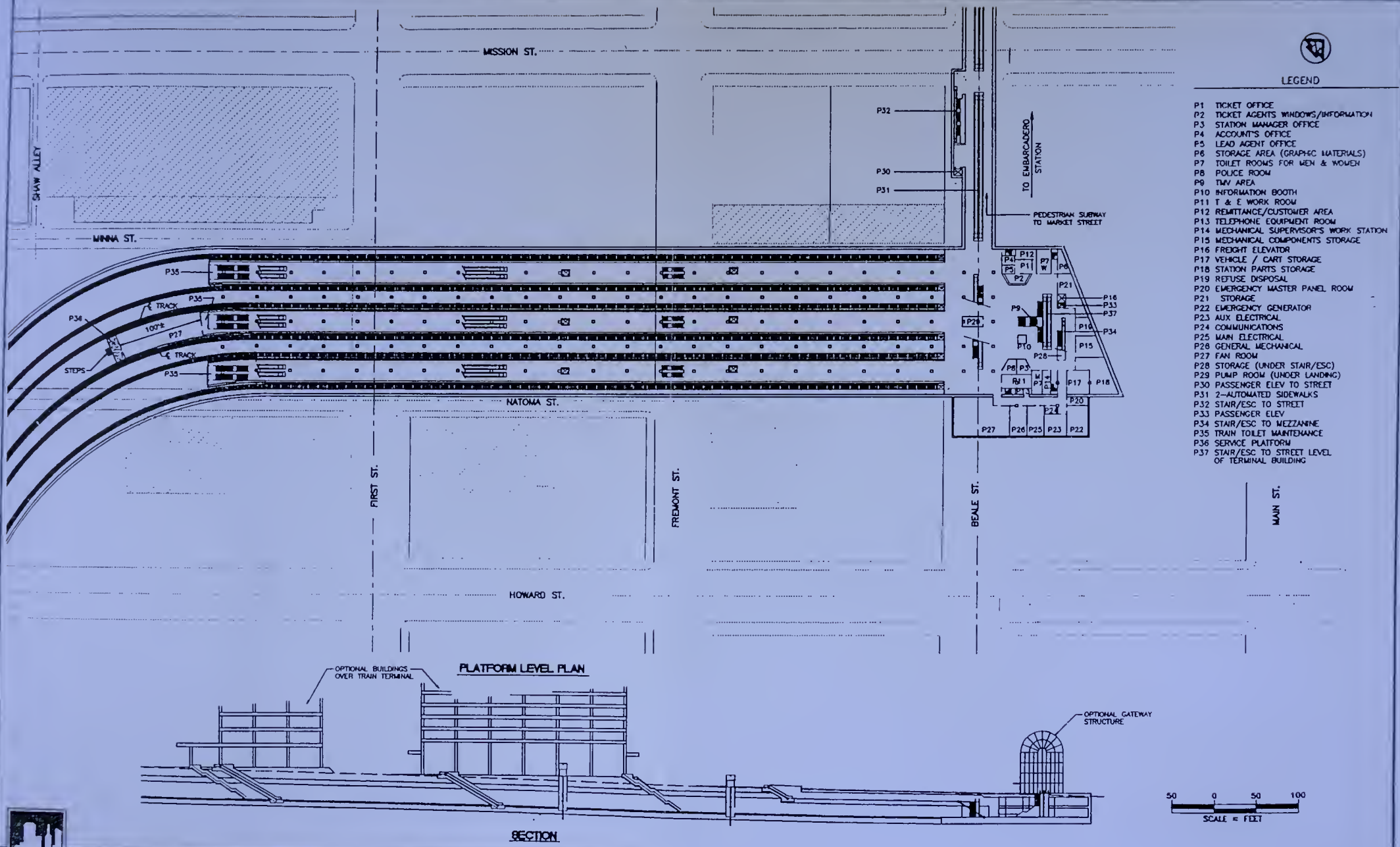
PROPOSED TRANSBAY TERMINAL SITE CALTRAIN STATION

Figure 2



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TRANSBAY TERMINAL RAIL STATION - PLAN AND ELEVATION

Figure 3

The underground station would incorporate a 950-foot underground walkway with moving sidewalks under Beale Street from Market to Natoma Streets connecting CalTrain with BART/Muni Metro at the Embarcadero Station. A Muni/Samtrans bus terminal would be located on the surface at the east end of Transbay Terminal site in the block between Fremont and Beale Streets. Other bus operations that the Transbay Terminal currently supports would be relocated to a new facility either in the block across Beale Street from the new rail station or above the underground rail station. The Muni F-line historic streetcar, which currently has its terminal loop at the Transbay Terminal, is scheduled to extend by the end of 1998 up The Embarcadero with a terminal loop next to Fisherman's Wharf.

1.2.3 Propulsion System. Electric propulsion was selected for the subway portion of the extension because of ventilation and safety concerns with diesel and liquefied natural gas propulsion systems. The line is currently operated by diesel power. The JPB is evaluating the following three electrification options:

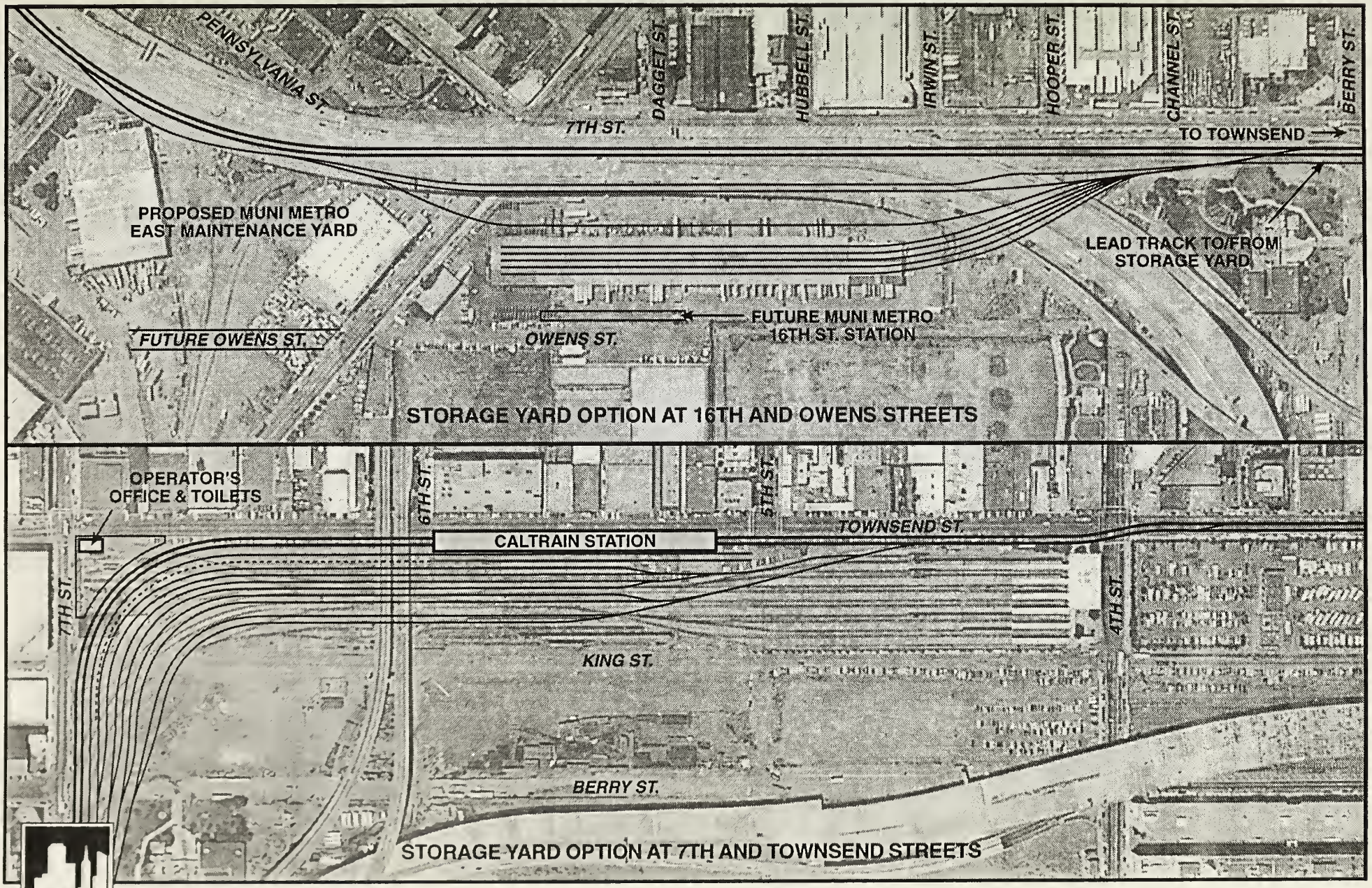
1. Full electrification (25 KVAC) - This consists of the electrifying the entire line from San Francisco to Gilroy with a 25,000-volt alternating current (25 KVAC) overhead catenary system.

2. Dual mode/power pack concept (25 KVAC) - A dual mode system operates using electric power or diesel generated power. The idea is to electrify in the tunnel, where it is impractical to utilize diesel power, and use diesel power outside the tunnel (to reduce the cost of electric wires and equipment). One dual mode option is the"power pack" concept. In this option, the power packs would convert the alternating current into direct current for the electric motors of the current F-40 diesel-electric locomotives. In this concept, a second unit, either new or rebuilt from an old locomotive, would be semi-permanently coupled to each existing diesel-electric locomotive. The power pack would be equipped with the necessary equipment to provide direct current via connecting cables to the motors of the existing diesel-electric locomotives. It would also provide Head End Power (HEP) for lights and heat/air conditioning and compressed air for brakes.

3. Dual mode locomotives (1,500 VDC) - In the second dual mode option, the extension portion of the line would be electrified with a 1,500-volt direct current (1,500 VDC) overhead catenary system to supply power to conventional dual mode locomotives.

Dual mode operation (using either the power pack concept or dual mode locomotives) would allow trains to switch from diesel to electric power without stopping prior to entering the tunnel portion of the extension. Upon exiting the tunnel when leaving the new terminal, the diesel engine of the locomotive would be restarted to power the train over the rest of the line.

1.2.4 New Storage Yard. As illustrated by Figure 4, two potential storage yard locations have been identified. One site would be just east of the I-280 freeway, west of Owens Street, and north of Sixteenth Street. The other site would be located between Townsend and King Streets



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ALTERNATIVE STORAGE YARD LOCATIONS AND CONFIGURATIONS

Figure 4

in part of the area currently used for the terminal tracks. The Townsend and King Streets in part of the area currently used for the terminal tracks. The Sixteenth Street yard would be approximately two miles from the new terminal station. The Townsend Street yard would be approximately 1.5 miles from the new terminal station.

A storage yard is needed because the four to six tracks planned at the terminal station would not allow for the mid-day storage and maintenance functions that currently are available on the 12 station tracks at the Fourth and Townsend terminal. Trains that would not make return trips in the morning would be taken to the yard for mid-day storage and then brought back to the terminal in the afternoon. The yard would also be a location for car cleaning, minor maintenance and repairs, and fueling.

1.3 Study Scope and Approach

The simulation analysis of the rail operating characteristics of the proposed extension of CalTrain from south of the current terminal station to the Transbay Terminal site was performed by Corporate Strategies, Inc.(CSI). This analysis covered both the train performance capabilities over the proposed alignment and the rail traffic congestion impacts of the current and future schedules in the new terminal facility. For the analysis, CSI used its RAILS™ (Railway Analysis and Interactive Line Simulation) package, which provides both train performance calculator (TPC) capabilities and train dispatching simulation (TDS) analysis.

Three different alignments were analyzed with four different train consists (combinations of locomotives and cars). The resulting train performance characteristics were then used with existing schedules to determine the operating patterns and potential for conflict among trains. A hypothetical future peak period was also simulated with increased peak-hour trains to test for possible conflicts associated with higher frequency service. Since the running times were not dramatically different among the alignments, only one set of running times for trains was analyzed for traffic interference patterns.

1.4 Report Organization

The remainder of the report discusses the present and future potential operations. Section 2 summarizes the existing CalTrain operations. Section 3 describes the future operations under the No-Build Alternative. Section 4 discusses future operations under the Transbay Terminal Site Alternative. Section 5 summarizes the effect of possible future intercity/high-speed train service on terminal operations. Section 6 presents the summary and conclusions.

2. EXISTING OPERATIONS

2.1 Fourth and Townsend Station

The existing CalTrain terminal station, located at Fourth and Townsend Streets in the City of San Francisco, occupies the entire block between Townsend Street on the north and King Street on the south. The station area includes twelve tracks and six center platforms at ground level. Platforms are 18 feet wide and vary in length from 650 to 840 feet. Each platform has a single point of access controlled by a manually operated gate at the stub end of the tracks. Passengers waiting to board a departing train are kept behind the gate until shortly before departure time. Tracks between the platforms are spaced at 13 feet, which is less than the standard 14-foot minimum now allowed under current California Public Utilities Commission regulations, although less clearance is allowed for passenger-only tracks.

Seven tracks are used for revenue service during the morning and afternoon peak hours. Fewer tracks are used for revenue service during off-peak hours. Over the course of a day, all 12 tracks are used for revenue service or for train storage and switching. The terminal area also has storage and service tracks, where various activities such as fueling, cleaning, and light maintenance are performed during the mid-day. Other maintenance is performed at the San Jose terminal or under contract off-site.

2.2 Operations with 60-Train Schedule

CalTrain weekday service currently consists of 60 trains per day -- thirty in each direction. On Friday evenings, there is an extra southbound train which departs just after midnight. Weekend service is more limited, with 26 trains on Saturday and 19 on Sunday or holidays. Trains are typically four or five cars long, powered by a single diesel-electric locomotive. All trains currently enter and depart the station with the same number of cars; there is no change in train length at the terminal. During special events, which occur a few times each year, trains may be up to ten cars long with two locomotives. Existing gallery cars have a seating capacity of 148 people, while cab cars have 115 seats and space for 24 bicycles.

Weekday service is focused in the peak periods and in the peak direction, i.e., a majority of morning trains head north to San Francisco in the peak period and a majority of afternoon trains head south out of the city in the peak period. During the morning peak hour from 7 to 8 am, seven trains arrive at and four depart from the current San Francisco terminal. In the evening peak hour from 4:50 to 5:50 pm, six trains leave and three arrive in San Francisco Hourly service is operated during off-peak hours, with trains departing San Francisco on the hour and arriving from San Jose at approximately the half-hour.

Trains operate in push-pull mode, with the locomotives located on the south end (pushing toward San Francisco). Cab cars are located on the north end. This configuration minimizes the walk from the passenger cars to the platform gates at the San Francisco terminal.

2.3 Signals and Control

The signal system for the CalTrain line from San Francisco to Gilroy is an automatic block system with fixed block signal located along the tracks and spaced approximately one to three miles apart to indicate whether the track ahead is clear to proceed. Portions of the line near San Jose and at the San Francisco terminal are equipped with centralized traffic control (CTC) controlled from San Jose. The balance of the line is double track signaled for one-direction running on the right-hand track. Trains normally operate on the right-hand track between San Francisco and San Jose. The train crews and the dispatcher use radio for communication.

3. FUTURE OPERATIONS WITH NO-BUILD ALTERNATIVE

The CalTrain terminal station is assumed to remain at Fourth and Townsend Streets under the No-Build Alternative. There likely would be an increase in the number of trains per day. Increased levels of 66, 72, 86 and 114 daily trains have been proposed in the past, with most trains added during the mid-day, off-peak hours. Under these proposals, peak hour service would be only slightly increased over the current schedule. Thus the peak operating demands on the terminal would change only slightly. The higher frequency of trains would actually reduce the amount of mid-day storage needed because more trains would be kept in operation throughout the day. No changes are anticipated to maintenance or control procedures. Similarly, the types of signal and communication systems are not anticipated to change solely as a result of train frequency changes.

4. FUTURE OPERATIONS WITH TRANSBAY TERMINAL SITE ALTERNATIVE

This chapter presents assumptions used in evaluating railroad operations in the CalTrain extension and terminal. It is important to understand that operational efficiency is highly dependant on physical assumptions as well as operating characteristics (e.g., the schedule). Physical assumptions include how long it takes to "turn a train," i.e., the time it takes for a train to enter the terminal, allow passengers to alight, allow passengers to board, and then leave the terminal. The analysis described below is conservative in that it does not assume any changes in physical assumptions or operating characteristics. For example, a simple change in schedule could reduce the number of platforms required for CalTrain during the peak period.

4.1 Assumptions

4.1.1 Number of Trains. As noted in Section 3, service level increases under consideration by the JPB include the addition of trains, mainly during non-peak hours. Current service levels include 60 trains per day and increased levels of 66, 72, 86 and 114 daily trains have been proposed. To analyze station platform track needs and constraints, increased CalTrain morning peak hour service is assumed to consist of ten trains arriving and four trains departing. In relation to current morning peak hour operations, this assumption represents an increase of three arriving trains, with no increase in the number of outbound trains.

4.1.2 Train Configuration. For the future service assumption, each arriving train would consist of a maximum of ten cars powered by one locomotive. Current trains are typically four or five cars long with one locomotive. For this analysis, each car is considered to have a maximum of 160 passengers, yielding a total maximum passenger load of 1,600 passengers for a ten-car train.

4.1.3 Train Turnaround. For the operations analysis, each train is assumed to spend a minimum of ten minutes in the terminal station if it were returning to the yard at Sixteenth and Owens Streets. (The Townsend Street yard option was not analyzed.) If the train were returning to regular service, it was assumed to spend a minimum of 23 minutes in the terminal. This period is based on review of existing operations and can be broken down into alighting and boarding of passengers, reversing the train, boarding/deboarding of mobility-impaired passengers, and schedule recovery, which are discussed below.

Passenger Alighting and Boarding. Based on observations of alighting at the existing terminal, it is estimated that all passengers can exit a fully loaded commuter rail car in under two minutes. Less accurate estimates are available for boarding, given that current boarding takes place during the interval of time between the gates opening and the train doors closing. This interval may be 5 to 15 minutes. It appears reasonable to assume that passengers waiting to board an incoming train could all board within three minutes. Thus, the portion of the train turnaround time for passenger alighting and boarding has been assumed to be five minutes. This interval does not include any delays for mobility-impaired passengers.

Reversing the Train. In terms of train operations, a minimum of five minutes is needed to reverse a commuter train, using a second crew either waiting on the platform or already on the opposite end of the train. This operation consists of the conductor and train crew disembarking inbound passengers, walking through the train to ensure that everyone is off, and making a quick check for lost articles. At the same time, the engineer secures the operating cab. The engineer and conductor of the departing train then make the required brake test and board the outbound passengers. Additional operations, such as uncoupling to change train length, would extend the minimum turnaround time. Thus, with a second crew standing by, the minimum time that a train could be returned to revenue service would be about five minutes, assuming no delays in the brake test or deboarding/boarding and no need for schedule recover.

Without the second crew, the minimum time to reverse the train would be about two to three minutes longer to allow the engineer to walk the length of the train, or 7 to 8 minutes to reverse the train. A more reasonable time of 10 minutes just to complete the brake test was assumed for the schedule analysis, which corresponds to the 10 minutes allowed for trains to return to the yard. Allowing an additional 3 minutes to board passengers, plus 10 minutes of schedule recovery, results in the assumption of a turnaround time of 23 minutes for trains returning to revenue service. Passengers are assumed to be boarded after the brake test to allow time to find problems that could force a change of equipment.

Mobility-Impaired Passengers. For ADA compliance, the solution applied for CalTrain rolling stock since July 1995 involves the use of a hand-operated lift (similar to that currently used by Amtrak), with a modified longer ramp into the car and some stanchions removed from the steps. New CalTrain commuter rail cars, soon to be ordered, will have on-board, mechanically-operated ramps. In either case, it is assumed that approximately five minutes will be required to deboard and board mobility-impaired passengers requiring the use of a wheelchair lifting device, and that this operation will not add to the total length of time required to turn the train.

Schedule Recovery. Amtrak's standard allowance for schedule recovery is 7 percent. Based on the longest runs of about 2 hours 20 minutes in the morning peak (Trains #31 and 41), the schedule recovery allowance should be about 10 minutes.

4.1.4 Platform Configuration. The platform length needed for the maximum ten-car train is 850 feet. The locomotive and power pack, if used, would extend beyond the length of the platform. As illustrated by Figure 3, the proposed terminal station would have six tracks and three center platforms, each 850 feet long and 28 feet wide, to serve CalTrain and possible future high-speed rail passengers. Each platform would have escalators and stair access to the street level as well as elevators and/or ramps for disabled persons and bicycle users.

All six platforms will be compatible with possible future intercity/high-speed rail service. For flexibility of operation, all six platforms are assumed to be used by CalTrain until provision of intercity/high-speed rail. CalTrain and intercity/highspeed rail would develop a plan for sharing platforms depending on schedule demand after inception of intercity/high-speed rail service.

4.1.5 Track Configuration. Track geometry currently has been developed for the CalTrain alignment options (Figure 1). For this analysis, three cases have been analyzed:

1. The base option with primarily 20-mph curves at critical points, including the short-radius tunnel at Townsend and Colin P. Kelly Streets;

2. A revised option with somewhat different curvature, but still 20 mph; and

3. A revised option with a long, 50-mph curve at Townsend and Colin P. Kelly Streets, the critical point on the line.

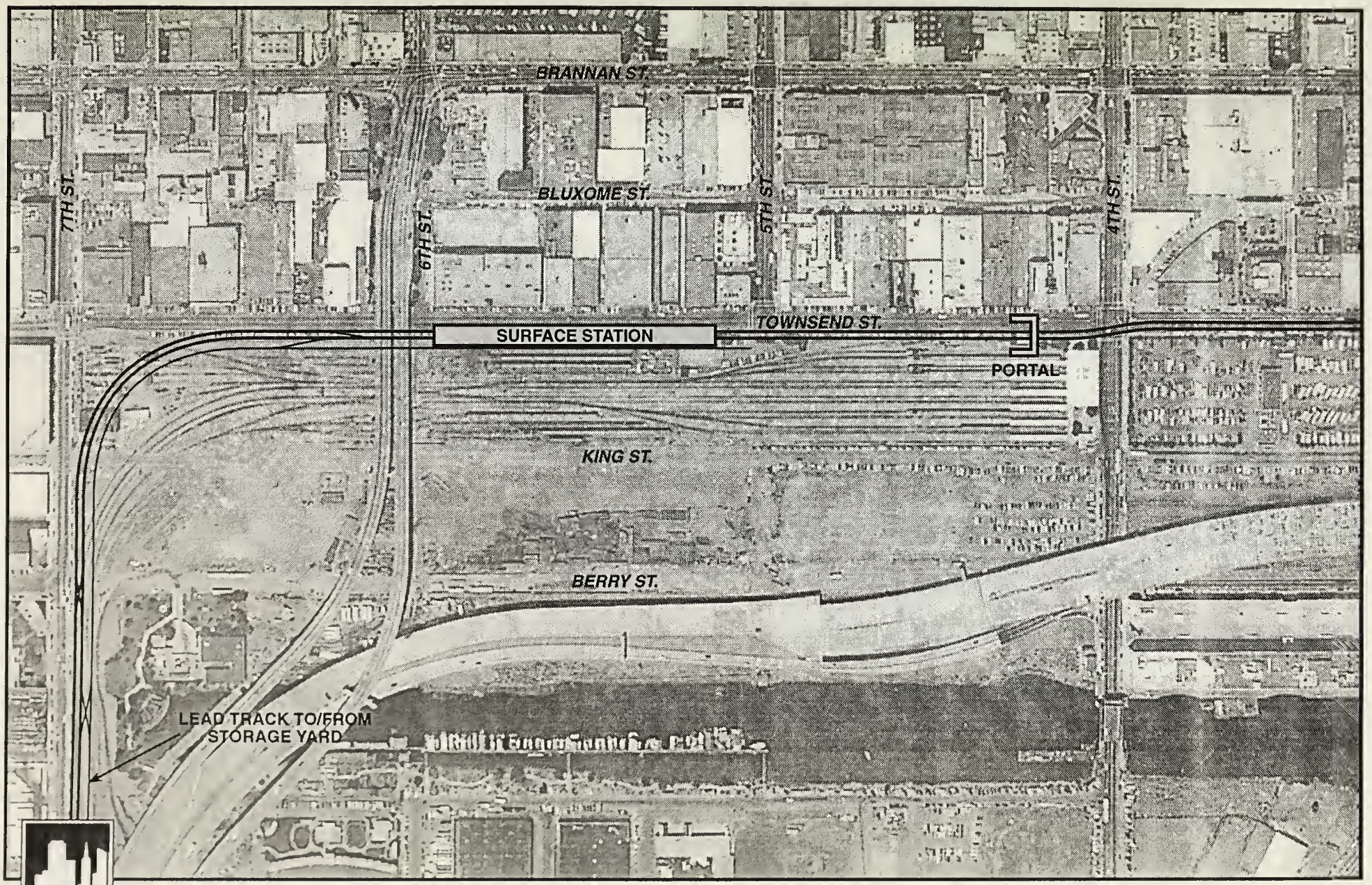
All of the options represent the "worst-case" because of conservative assumptions on allowable train speeds and include restrictions on track crossover locations imposed by a twin-bore tunnel. They were used as the basis for calculating travel times and train movements in and out of the terminal station. Thus the 20-mph option presents a conservative estimate of travel times while the 50-mph option tests the fastest possible option. It should be noted that the actual curve speeds under consideration are 30 mph for the short-radius tunnel, 20-mph for the medium-radius tunnel, and 50 mph for the long-radius tunnel.

A double tracked line signaled for operation in either direction on either track from the present CalTrain line near Seventh and Hooper to the new station was assumed. Power switches and typical railroad color light signals would be used. For operating flexibility, a universal crossover was assumed just west of Sixth Street. At the terminal station, switches and crossovers would be arranged to allow trains to use any station platform track from either of the two main tracks.

The connecting track to the storage yard at Sixteenth Street, called the yard lead track, would join the main track just south of Berry Street. There would be a crossover from the northbound or inbound track to the southbound or outbound track just north of the lead track switch. This crossover would allow northbound trains to switch to the southbound track without stopping. Southbound trains on the normal right-hand track could also use this crossover to switch to the northbound track and then to the yard without stopping. Because this crossover faces the normal direction of train traffic, it is called a facing point crossover. In the Townsend Street South Side Option, the lead track extends to a third track at the proposed Mission Bay Station (Figure 5)

Figure 6 depicts a schematic layout of the extension that illustrates the vertical alignment, showing the grades for the option using the short-radius curve at Townsend and Colin P. Kelly Streets. The maximum grade would be 2.7 percent for 1,400 feet, which is reached as the track descends into the tunnel along Townsend Street. The long-radius tunnel at Townsend and Colin P. Kelly Streets would have a similar vertical profile but would maintain the maximum 2.7-percent grade for a distance of 1,800 feet.

4.1.6 Storage Yard Configuration. Figure 4 illustrates the alternative locations and layouts of the proposed storage yard. For the Sixteenth Street yard option, most of the yard tracks would be located east of the freeway structure because space under I-280 is restricted by the support columns. This yard consists of three tracks that would connect directly to the mainline at both



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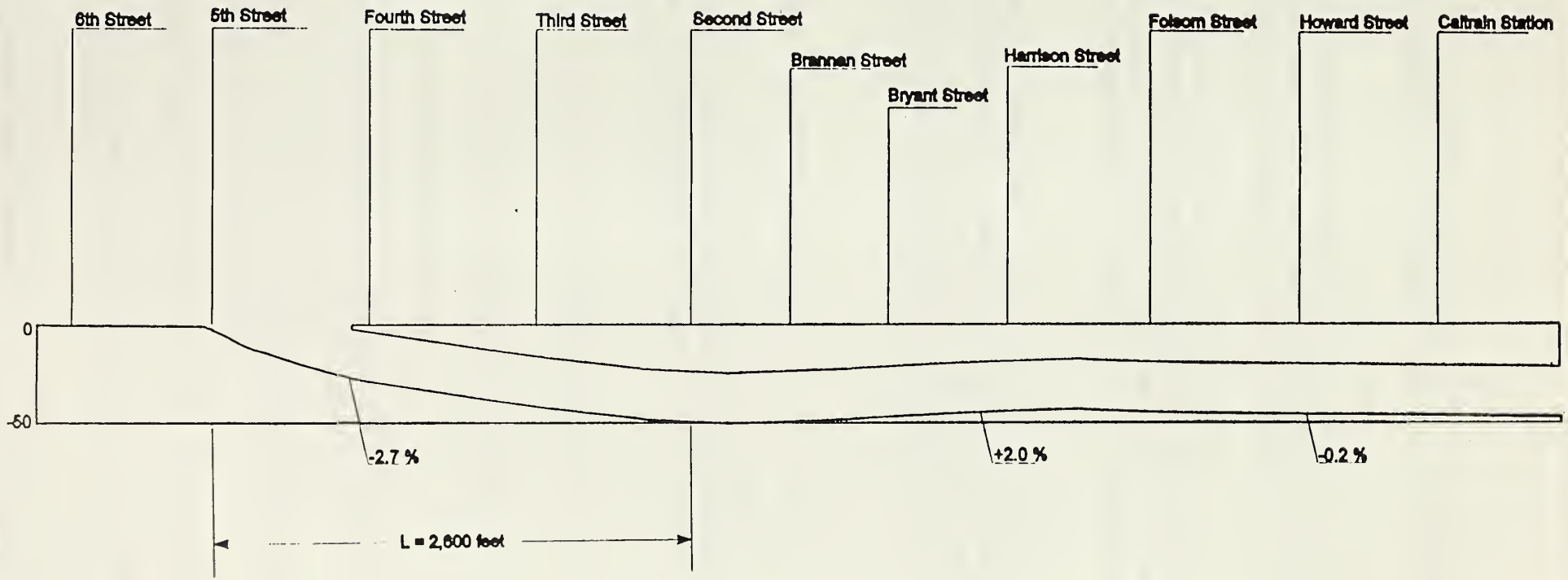
TOWNSEND-SOUTH SIDE OPTION

Figure 5



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EXTENSION ALIGNMENT VERTICAL PROFILE

Figure 6

ends of the yard and five stub end tracks that would connect directly only at the terminal (north) end of the yard. On the south end of the yard, the yard lead track switch would be just north of Mariposa Street.

The mainline track would have a crossover south of this lead track switch. Trains exiting from the south end of yard could move to either main track. Because this crossover trails or faces away from the normal direction of train traffic, it is called a trailing point crossover.

The Townsend Street yard option, which was not analyzed, would have eight tracks, all of which connect to the mainline at both ends of the yard. The connection on the south end would be via a third track to the proposed Mission Bay Station. The yard lead switch on the north or east end of the yard would be midway between Fifth and Fourth Streets before the tracks descend into the tunnel.

4.2.7 Signals and Control. Signaling was assumed to be Centralized Traffic Control (CTC) operated by Amtrak's CalTrain controller in San Jose. The signal system would allow trains to safely operate closely behind one another to minimize the effect of minor schedule aberrations. The distance between signals in the extended alignment is proposed to be about 1,500 feet to permit the close following of trains. Traction power for the extension would also be controlled from San Jose.

4.2.8 Other Assumptions. Operations assumptions in the analysis include the following:

- All maintenance except unscheduled minor activities will be performed either at the San Jose terminal or under contract off site until a new CalTrain maintenance facility is built. Minor maintenance currently performed at Fourth and Townsend will be performed at the proposed San Francisco storage yard.

- Cleaning of trains will be performed at the storage yard. Each train will go through the yard once a day for cleaning.

- The storage yard will have facilities for fueling diesel locomotives.

- Train crews will be stationed at the storage yard.

- The new terminal station will have a supervisor and facilities for standby crews, as well as provisions for minor cleaning and limited minor maintenance.

- The station platforms will be uncontrolled and the operation will be barrier-free, similar to the operation of the San Jose terminal currently.

- Control of the signal system, power switches, and traction power will be from San Jose.

- The traction power will be broken into sections to minimize vulnerability to disruption and to facilitate maintenance.

4.2 Train Performance

Train performance capabilities of typical CalTrain equipment were analyzed for each of the three proposed alignments. The train configurations used were:

1. An F40PH locomotive and four cars,
2. An F40PH locomotive and five cars,
3. An F40PH locomotive and ten cars, and
4. An F59PH locomotive and ten cars.

The F59PH is a slightly more powerful locomotive than the F40PH. As noted in Section 1, the electric motors of the locomotive would be powered by the electric power pack or dual mode locomotive in the tunnel. Because the power pack approximates the weight of a second locomotive, an F40PH locomotive and five cars is the minimum effective train length that would be operated on the extension (configuration #2 cited above). Although the results are not presented here, an eleven-car train was also modeled to verify that the maximum length train would operate satisfactorily on the grades in the tunnel. Only one locomotive is needed even with the maximum length train.

Operation of trains was simulated over three alignment options approximately 2.5 miles in length as follows:

1. The base alignment with primarily 20-mph curves at critical points;

2. A revised option with somewhat different curvature, but still 20-mph curves; and

3. An alignment options with a long, 50-mph curve at the critical point on the line.

Free running times from the initial point of analysis to the terminal would take 7.0 minutes if a continuous speed limit of 20 mph were used from the first restrictive curve 0.7 miles along the line at Seventh and Townsend Streets until the station is reached. Alternative operations considered attempting higher speeds between the restrictive curves, or with the third alignment, raising the speed on the critical curve. Trip times for all options ranged from six to seven minutes, depending upon the particular alignment and train configuration. Trip times for the F40PH and four cars were the most responsive to speed increases because of the relatively high power-to-weight ratio, which allows quick acceleration after speed restrictions, and good grade climbing ability. Without assuming a stop at the proposed Mission Bay Station, the simulated running times in minutes for the three alignments with the F40PH and four cars were:

	Inbound	Outbound
Base Alignment - Only 20 MPH allowed north of Townsend Street	7.42	7.08
Base Alignment With higher speeds allowed between curves	6.79	6.20
Revised Alignment	6.93	6.28
50-mph Curve Alignment	5.97	5.44

The simulated train outbound times were slightly less than the train inbound times because inbound trains operate to the bumping post, while outbound trains were simulated to start 0.1 mile out for clarity in the model's graphical output, reducing time on the modeled section by about 0.4 minutes. Generally the base and revised alignments would require almost 7.0 minutes inbound and 6.25 minutes outbound. The long-curve alignment would reduce travel time for all trains by about one minute compared to the other two alignments simulated, though raising the speed on the short-radius curve to 30 mph reduces this difference to 0.5 minutes. Further curve straightening and curve speed increases using super elevation (banking the track on curves) could save a similar amount. The long-radius curve is at the critical point of the line because it is at the lowest part of the tunnel, and avoids the need to decelerate approaching the bottom of the grade, and then reaccelerate climbing away from the lowest point. That is, the long-radius curve would allow the train to maintain its speed so that it would not have to slow down right before the climb out of the tunnel.

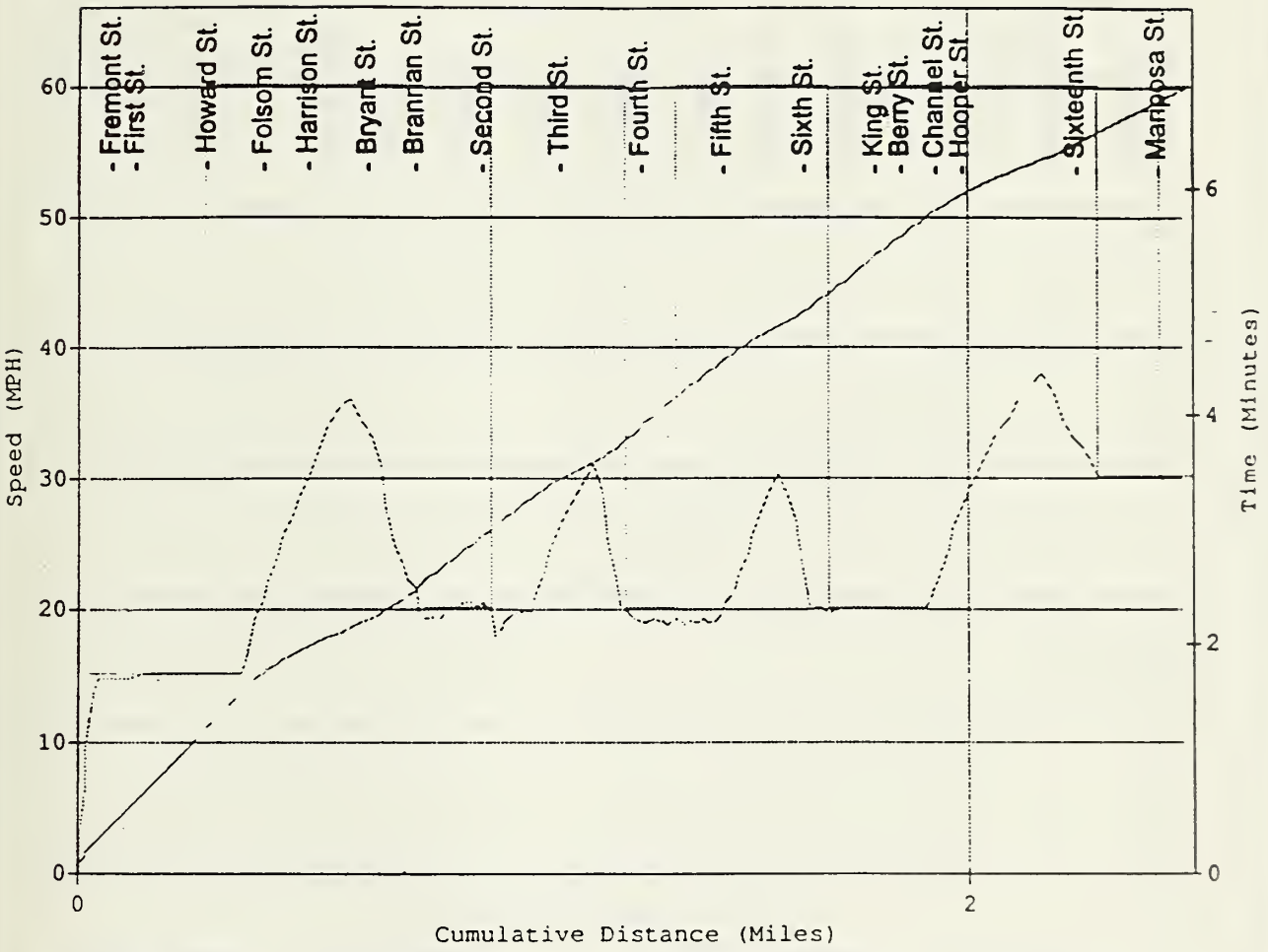
For the base alignment with higher speeds between curves, Figure 7 illustrates the travel times and speeds of two train configurations, an F40PH locomotive with five cars and an F40PH locomotive with ten California cars. California cars were assumed to be slightly lighter than the current cars. Additional cases are included in Appendix A.

4.3 Operations with 60-Train Schedule

4.3.1 Operating Parameters. A base 60-train weekday schedule (existing) was analyzed for a typical 24-hour period. Since the slowest running times are the ones most likely to cause congestion due to long track occupancies, the first alignment option was analyzed in detail by CSI.

All inbound trains were required to spend at least 10 minutes in the terminal before departing as revenue trains or moving to the yard at Sixteenth and Owens Streets. Trains from the yard were scheduled out of the yard about 20 to 25 minutes before their scheduled departure from the terminal. This allowed about five minutes to run from the yard to the terminal, 10 minutes for

F-40 with five cars



Total Time: 6.9 Minutes
Total Fuel: 11.0 Gallons
Total Distance: 2.5 Miles
Average Speed: 21.7 MPH

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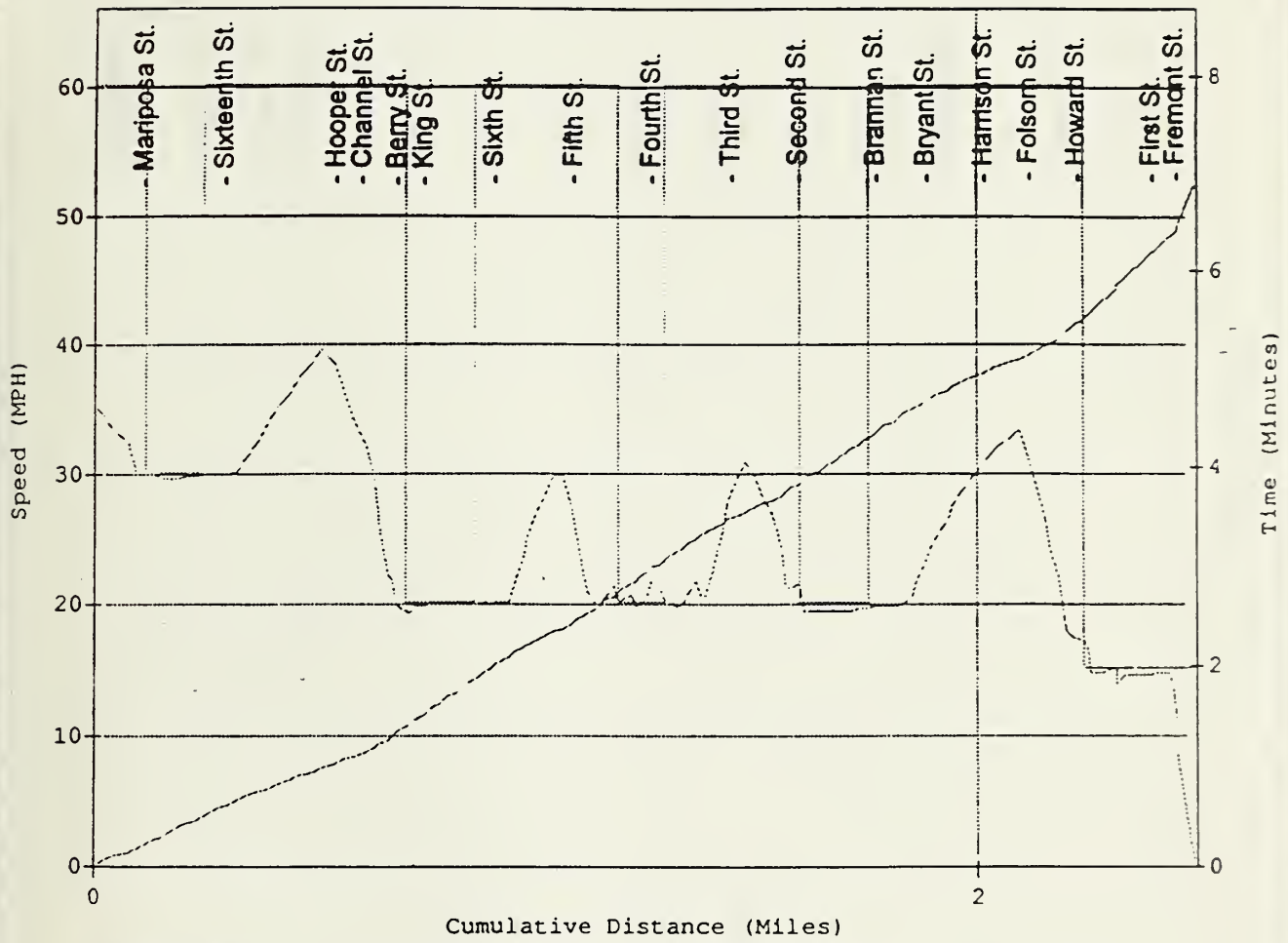
SPEED PROFILE FOR BASE ALIGNMENT OUTBOUND

Figure 7a

F-40 with five cars



Total Time: 6.9 Minutes
Total Fuel: 9.0 Gallons
Total Distance: 2.5 Miles.
Average Speed: 21.8 MPH

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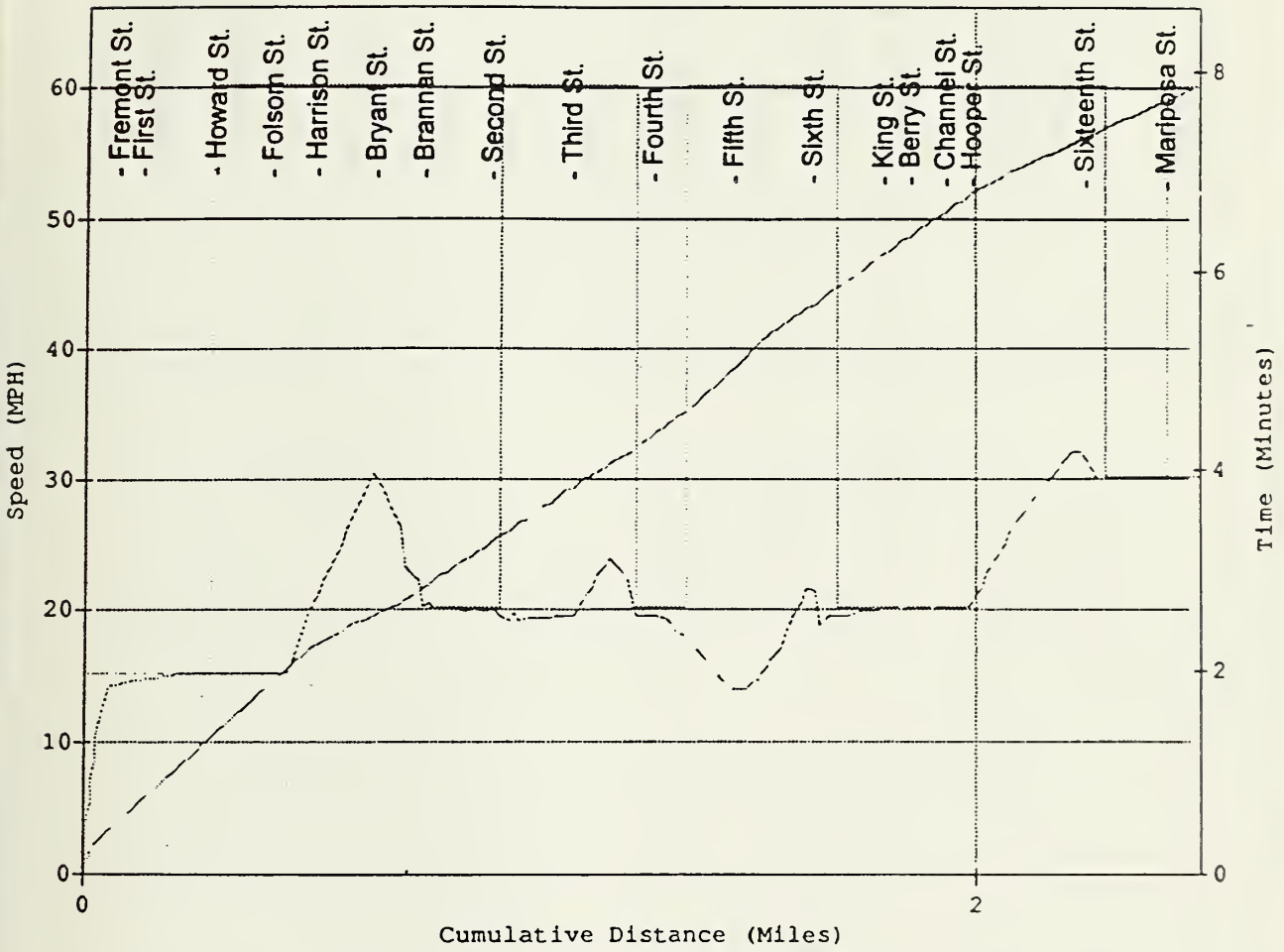
SPEED PROFILE FOR BASE ALIGNMENT INBOUND

Figure 7b

F40 with 10 California Cars



Total Time: 7.8 Minutes
Total Fuel: 14.0 Gallons
Total Distance: 2.5 Miles
Average Speed: 19.2 MPH

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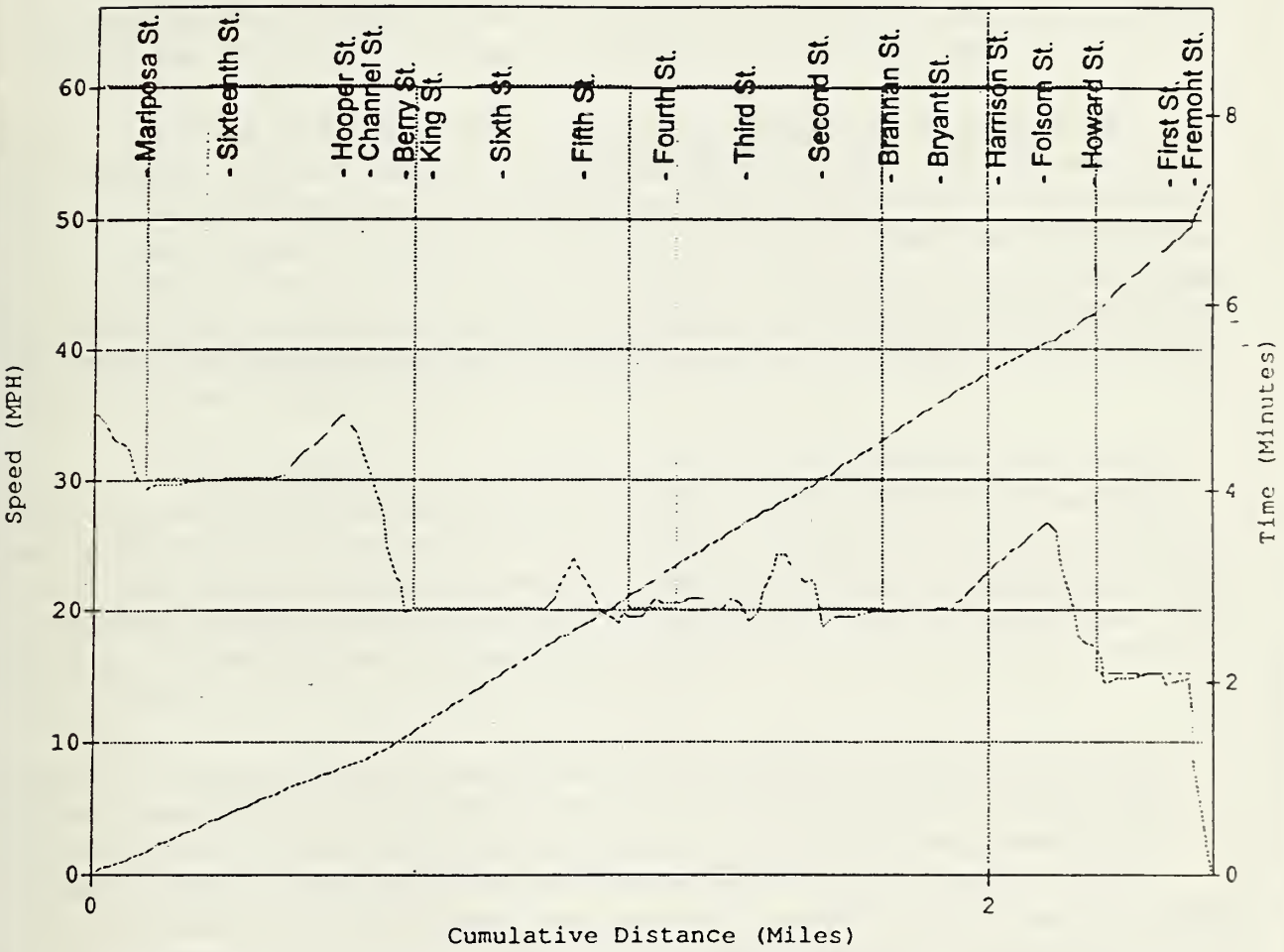
SPEED PROFILE FOR BASE ALIGNMENT OUTBOUND

Figure 7c

F40 with 10 California Cars



Total Time: 7.3 Minutes
Total Fuel: 9.0 Gallons
Total Distance: 2.5 Miles
Average Speed: 20.6 MPH

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SPEED PROFILE FOR BASE ALIGNMENT INBOUND

Figure 7d

the crew to turn the train, and 5 to 10 minutes to load passengers, depending on the time of day. Trains headed for the yard could leave anytime after the 10-minute turn delay. Inbound trains were scheduled into the extension segment three minutes after their scheduled time at 22nd Street, which is about a mile south of the start of the analysis segment. All regular trains were assigned to right-hand running in and out of the terminal. Trains going to the yard were allowed to use any track. No tracks were assigned to specific trains in the terminal itself.

4.3.2 Track/Platform Requirements. In the busier morning rush hour (seven inbound and four outbound in one hour), there are never more than four tracks used. In the afternoon, all tracks are used, mainly because train 59 coming in at 3:30 pm occupies track 1 until it leaves as 68 at 5:35 pm. At about 5:20 pm there are five trains sitting in the station, one of which arrived at 5:00 pm and does not leave until 6:00pm. To occupy only four tracks under the existing peak-hour schedule, two or more incoming trains in the afternoon would have to be dispatched to the yard for storage rather than being stored for extended periods in the terminal. Alternatively, the existing peak hour schedule could be adjusted to reduce track needs.

4.3.3 Operating Performance. A typical day of operations was analyzed, with all trains operating on their assigned schedule times. For this day, a total of 20 minutes of traffic delay was encountered by all operations. About a third of that was incurred by yard moves; another third was due to trains changing tracks entering or leaving the terminal. The largest delay to any one train was 2 minutes to train 65, waiting for outbound trains to clear the terminal area. Most other delays to scheduled trains were less than half a minute. No outbound train was even close to being delayed due to late arrival of an inbound train.

Overall, the proposed track and signal plant and operation appear to function smoothly, with minimal interaction among the various movements. Minor track improvements, as noted in Section 4.4 below for the 86-train schedule and that have already been incorporated into the design, would improve performance for the 60-train schedule. The yard location option at Townsend Street would perform slightly better than the Sixteenth Street option analyzed because it would be located 0.5 miles closer to the terminal and would have its yard switch about 1,000 feet closer to the terminal than the Sixteenth Street option.

4.3.4 Crew Requirements. Implementation of commuter train operations now based at the CalTrain 4th and Townsend station to a new, proposed terminal at the site of the Transbay Terminal will impact train operations, and related costs. In general, the crews will be on duty for longer periods of time, the trains will operate further distances, and the station operations will be more complex. This analysis has implicitly assumed that the current work schedules are the "best" for the current operation. Specifically, no effort has been made to determine, for example, if the present service schedule could be met with fewer crews, or if the same crews could be used more efficiently, i.e. work fewer hours and receive less pay.

Additional Travel Times and Distances. For revenue service, the proposed station at the TransBay Terminal will require all JPB commuter trains to travel an additional 1.3 miles, using an estimated four to five minutes of travel time (or less, depending on the final alignment chosen) in each direction.

Deadheading. Servicing requirements in addition to midday storage requirements are assumed to require each set of equipment, 15 sets for the current 60 train schedule, to make the 2.1 mile one-way trip from the TransBay Terminal to 16th Street Storage Yard and return, a total distance of 4.2 miles. Analysis of running times and the other associated activities such as changing ends (preparing the train for operation from the other end) and yarding (placing the train on a yard track) the train at 16th Street) indicates that an additional crew on-duty time of 15 minutes each way or 30 minutes should be allowed in planning for this move.

Precise identification of the change that these additional times and distances will have on crew assignments and costs is not possible without making assumptions as to how the schedules will change with the new station. In order to clearly define the possible cost implications of the proposed new terminal, two analytic assumptions, bracketing the probable future operations, were evaluated.

Analytic Assumptions. The following two sets of assumptions were made, and the results of each analyzed:

1. **Inbound arrival and outbound departure times at San Francisco will be held constant.** That is, trains will leave their origins four to five minutes earlier on inbound trips, and arrive at their destinations four to five minutes later on outbound trips. This assumes, in effect, that the service is oriented on San Francisco, and that arrival and departure times there are critical to customer satisfaction.

2. **Inbound arrival and outbound departure times at San Francisco will be four to five minutes later and earlier respectively.** Train times at other locations will remain unchanged. This assumes, in effect, that the relocation of the station has moved the customers sufficiently closer to their destinations and origins that the net effect is neutral or positive on the overall trip.

In fact, the schedules in effect after some period of adjustment (say one year) for operations to and from the new station would probably be some compromise of these two analytic assumptions.

Impact on Crew Assignment. The additional times and distances will affect crew assignment in on-duty times and crew turns. Federal law limits the time that train and engine operating personnel can work. In general, their total time on duty may not exceed 12 hours. If a break is allowed during the workday, the total elapsed time from initially on duty to finally off duty can be more than 12 hours only if the break is of four hours duration or more.

Even though the hours of service law applies equally to both engineers and trainmen (conductors and assistant conductors), the crew assignments for the current service are broken into 27 daily assignments for engineers and 23 daily assignments for conductors and trainmen (two-person crews) for weekday runs. Most of these assignments work one inbound and one outbound train. Three engineer assignments and seven trainmen assignments work four trains each. In addition, there are 16 extra individual assistant conductor assignments to augment the ticket collection on

the busiest trains. The crews do not work the same trains each day, but work in multi-week repetitive cycles. This practice appears to even individual salary earnings and help to avoid monotonous assignments that produce performance problems.

There are also extra board assignments that serve as vacation and sick leave backup for the regular personnel. The extra board personnel total 8 engineers, 8 conductors, and 7 assistant conductors. Table 2 summarizes the number of personnel and the number of trains worked by regular crew.

One of the three daily engineer assignments working four trains has a midday break of 4 hours 33 minutes. The additional time required for the greater distance required, approximately 15 minutes, will make the break time be so short as to make it not reliable. If the train before the break were more than 15 minutes late, then the four hour minimum break would not be possible. This would require using another crew for the second half of the day's work. The other two assignments that work four trains do so well within legal time limits, less than 10 hours on duty, and should not be affected. The probable best operating solution would be to establish one additional engineer assignment.

Four of the seven trainmen assignments that work four trains are on duty less than 10 hours, and should not be affected. One has no four-hour break and is on duty almost 11 hours 30 minutes. The other two assignments have breaks of 4 hours 33 minutes. These three assignments would probably best be met by adding three crews.

Because the extra trainmen assignments do not necessarily stay on the train for its entire run, there would probably be no effect on the number of extra trainmen required. Extra board personnel would probably increase in proportion to the increase in regular crews, which would require adding one conductor/assistant conductor pair.

Thus, as summarized in Table 2, the addition of the additional time and distance to all trains, and the additional deadheading required to move the midday storage location from the passenger terminal to a yard over two miles from the passenger terminal will probably require the addition of one engineer's assignment and three trainmen assignments among the regular crew and one conductor/assistant conductor pair for the extra board personnel.

4.4 Operations with 86-Train and More Frequent Schedules

4.4.1 Operating Parameters. To test the potential effect of more frequent train schedules, a simulation was conducted of a hypothetical morning peak hour of 10 inbound trains scheduled at six-minute intervals. Four trains were turned to outbound trains, with 23 minutes to unload, load and provide for schedule recovery. The remaining six trains were sent to the Sixteenth Street yard with a 10-minute turn time. The Townsend Street yard option was not analyzed.

Reverse running (trains would operate on the left-hand track) between the yard entrance and the terminal appears to be the most efficient way to operate during the morning peak. To minimize

TABLE 2. EFFECT OF EXTENSION ON TRAIN CREW REQUIREMENTS

Category	Engineers	No. Trains Worked Each Crew	Total Daily Trains	Train Crews*	No. Trains Worked by Each Crew	Total Daily Trains	Extra Assistant Conductors
Regular Crew	24	2	48	16	2	32	16
	3	4	12	7	4	28	
Subtotal	27	6	60	23	6	60	16
Required New Crews	1			3			0
% Increase	3.7%			13.0%			0.0%
Extra Board	8			8**			
Required Increase at above %	0			1			

*Two-person crews

**8 conductors, 7 assistant conductors

interference in the terminal area, outbound trains were scheduled on the hour, and at 12, 30, and 42 minutes after the hour, rather than every 15 minutes.

The rationalized schedule of departures every 15 minutes could probably be maintained with the following two fairly minor track improvements:

1. Extend Yard Entrance Lead to Sixth/Townsend. Extending the yard entrance lead north/east to Sixth and Townsend Streets would reduce interference and provide more flexibility to the operation. Without the proposed track layout, trains returning to the yard must use a short section of mainline track at Berry Street common to the route of inbound trains. Hence they would have to weave with those trains to get to the yard. Extending the lead to Sixth Street would eliminate this, allowing more flexibility in moving trains to and from the yard.

2. Add Facing Point Crossover. Additionally, a second facing point crossover just south of where the yard lead enters the main tracks would allow mainline trains to crossover in parallel with trains entering or leaving the yard.

Subsequent to this analysis, these suggested track improvements were incorporated into the current design. The Townsend Street yard option would permit even more improvement in operations.

Additionally, operations could be further improved in the Townsend Street South Side Option (Figure 5) by extending the third or lead track across Fifth Street and connecting it with both mainline tracks. This track modification would avoid the need for reverse running of trains in the morning peak, which would also simplify the operation of the Mission Bay Station (discussed in Section 6.4 below). Because the longer yard lead track would effectively add extra yard capacity, returning six trains per hour to the yard would not create a problematic queue for the four outbound revenue trains, with the inbound trains spaced on the average of every six minutes.

4.4.2 Track/Platform Requirements. With the unimproved track geometry, five terminal tracks would be required to handle the hypothetical future maximum morning traffic of ten inbound trains per hour. The combination of making the suggested track improvements and dispatching more trains to the yard would reduce this requirement to four tracks. Track requirements for the afternoon peak would be similar.

4.4.3 Operating Performance. In general, the hypothetical future morning higher frequency peak operation runs relatively smoothly. This result is despite the somewhat varied nature of the outbound patterns due to the mix of trains going to the yard and the scheduled mainline operations. Some juggling of schedules and occasional overriding of simulation model logic in the analysis would probably further reduce simulated delay.

The evening peak would operate adequately as well because the same traffic volume can be handled in the morning peak. Additionally in the evening, right-hand running of trains would be favorable for traffic operations, with trains moving from the yard to the terminal on the right-hand track.

4.5 Operating Characteristics

Extension of CalTrain commuter train service to the proposed Transbay Terminal station will increase operating expense. This increase will come from two factors.

- All trains will operate about 1.2 miles further to the new station.
- Trains will not be stored and serviced during the midday at their arrival location, as is now possible with the terminal at Fourth and Townsend. Each set of equipment that currently lays over and is serviced in San Francisco will make a round trip to the proposed yard at Sixteenth Street.

Common indicators of commuter rail operating expense are train miles and car miles. The current CalTrain 60-train schedule with trains sized as at present generates an estimated 938,000 annual train miles and 3,930,000 annual car miles. The proposed operation with the same train sizes and similar schedules would add about 26,000 annual train miles and 110,000 annual car miles. Approximately 22,000 of the train miles and 90,000 of the car miles are attributable to the increase in distance to the new terminal station. The balance is due to the additional deadheading of the trains laying over in San Francisco during the midday. That is, six peak-hour trains would be stored in the yard, and all other trains would go through the yard once a day for cleaning.

4.6 Mission Bay Station

Two of the options for portal locations along Townsend Street include a surface station in Mission Bay (see Table 1). Track geometry has been designed to accommodate such a station. The operations analysis performed as part of this study included a travel time provision for this station. Provisions for this station have minimal impact on operations at a new end-of-line terminal, given that the Mission Bay station would be located south of the intermediate signal, which is part of the assumed track and signal configuration for the terminal approach tracks. A Mission Bay Station would increase running times for all trains that stop there and could limit line capacity if dwell times were longer than approximately one minute.

Because of the need to run trains on the left-hand track in the morning peak-hour operation, the Mission Bay station platforms would need to switch functions between the morning peak and other times of the day. That is, the outbound and inbound platforms would reverse roles during the morning peak-hour operations. Alternatively, a center platform could be used, or the trains could always be run on the left-hand track until south of the Mission Bay Station.

In the Townsend Street South Side Option, reverse running through the Mission Bay Station could be avoided by extending the third or yard lead track across Fifth Street to connect with the two main line tracks. Trains moving to the yard would then switch to the yard lead track prior to reaching the station, permitting normal operation of trains in the station. The longer lead track would also allow trains to avoid reverse running altogether, simplifying the morning operations.

5. EFFECT OF FUTURE INTERCITY/HIGH-SPEED TRAIN SERVICE

There is considerable interest to include provisions for future intercity/high-speed rail trains at the new downtown San Francisco CalTrain terminal. Therefore the potential for intercity/high-speed rail passenger trains has been included in this analysis. Current passenger train service along the Peninsula corridor north of San Jose consists of commuter service only. Since 1971 there has been no intercity passenger rail service in this corridor. Intercity rail service in the United States is the responsibility of the National Railroad Passenger Corporation (Amtrak). The JPB is authorized to run commuter service only.

5.1 Platform Configuration

The downtown terminal has been designed with six track and three platforms. As indicated in the operations analysis, CalTrain, with certain schedule adjustments and minor physical improvements, could function with less than six tracks. Intercity/high-speed train service could operated from the tracks not being used by CalTrain. A detailed plan for platform and track usage would be developed as intercity/high-speed train schedules were developed.

5.2 Special Intercity/High-Speed Passenger Requirements

The typical CalTrain commuter passenger and the typical intercity/high-speed rail passenger differ in their needs and requirements and the manner in which planning for the station must occur. Commuters are familiar with the station and transit system, can navigate the station easily, require minimal amenities, and carry little if any luggage. Intercity passengers often have luggage of some kind, may not be familiar with the station and the station area, and probably require some assistance with transportation connections upon exiting the station. In addition, intercity trains may be carrying freight, mail or other non-passenger related materials which require special handling.

In terms of exiting and circulation requirements, intercity passengers would necessarily spend more time on the station platform and in the station itself. In addition, because of luggage and other carry-on items, normal circulation would require additional area per passenger to be comfortable. An emphasis on utilization of the escalators and heavier usage of the elevators would be anticipated. The platforms have been designed to accommodate the needs of both types of travellers, although some improvements will be necessary to provide additional amenities for intercity/high-speed rail passengers.

5.3 Impact on CalTrain Service

In conclusion, the intercity/high-speed train service would be viable with the current extension design. Furthermore, there exists a possibility, especially with the provision of high-speed rail service, for passengers to use intercity rail service as express trains on the CalTrain route, thus significantly improving passenger service.

6. SUMMARY AND CONCLUSIONS

6.1 Running Time

Free running times from the initial point of analysis to the terminal would take 7.0 minutes if a continuous speed limit of 20 mph were used from the first restrictive curve 0.7 miles along the line at Seventh and Townsend Streets until the terminal station is reached, a distance of approximately 1.5 miles. Trip times for all options analyzed ranged from six to seven minutes, depending upon the particular alignment and train configuration, and not including an additional one-minute increase for a stop at the proposed Mission Bay Station. This trip time would be an increase of four to five minutes in comparision to trips ending at the current terminal at Fourth and Townsend. The long-radius curve alignment would save about half a minute to a minute over the other two alignments. Further curve straightening and curve speed increases using super elevation could save a similar amount. Only one locomotive is needed for power even with the maximum length train.

6.2 Track/Platform Requirements

6.2.1 Current Schedule. In the busier morning rush hour (seven inbound and four outbound in one hour), there would never be more than four tracks used. To occupy only four tracks in the afternoon under the current schedule would also be possible if two or more incoming trains in the afternoon were dispatched to the yard for temporary storage rather than being stored for extended periods in the terminal. Alternatively, the current schedule could be modified.

6.2.2 Future Higher Frequency Schedules. With the track geometry unimproved over the base alignment, five terminal tracks would be required to handle the hypothetical morning traffic assumed to represent the effect of future 86-train schedules. The combination of making track improvements recommended in Section 6.2.3 and dispatching more trains to the yard would reduce this requirement to four tracks. The Townsend Street yard option would also improve operations somewhat. Track requirements for the afternoon peak would be similar.

6.2.3 Recommended Track and Operating Improvements. To improve operating performance, particularly for possible higher frequency train service in the future, two track improvements were recommended and have subsequently been incorporated into the design:

1. Extend the yard entrance lead north/east to Sixth Street;

2. Provide a second facing point crossover just south of where the yard lead enters the main tracks.

For maximum efficiency, the track between the downtown terminal and the yard entrance should be operated with reverse running during the morning peak. That is, trains would operate on the left-hand track between the terminal and the yard entrance, rather than on the normal right-hand track. Alternatively, in the Townsend Street South Side Option, the yard lead track could be extended across Fifth Street to avoid the need for reverse running, as well as simplifying operations at the Mission Bay Station.

6.3 Operating Performance

6.3.1 Current Schedule. Overall, the proposed track configuration and operation appear to function smoothly, with minimal interference among the various movements. Minor track improvements noted above would improve performance.

6.3.2 Future Higher Frequency Schedules. In general, the hypothetical future morning higher frequency peak operation would run relatively smoothly. The evening peak would operate adequately as well.

6.4 Conclusions

For the current CalTrain schedules, the proposed new terminal at the Transbay Terminal site could be successfully operated with only four of the proposed six tracks. Consequently, two tracks could be reserved for possible future intercity rail service.

For hypothetical future CalTrain schedules with higher frequencies, the train simulation program demonstrated that the morning peak period could be operated with five terminal tracks. It would be possible to reduce the number of required tracks to four with track and dispatching changes. The Townsend Street yard option would also improve operations somewhat. Alternatively, the yard lead track could be extended across Fifth Street to avoid the need for reverse running in the Townsend Street South Side Option.

APPENDIX A - TRAIN SPEED PROFILES

This appendix includes sixteen graphs of projected train speeds over the proposed CalTrain extension in San Francisco for the following train configurations:

1. An F40PH locomotive and four cars;
2. An F40PH locomotive and five cars;
3. An F40PH locomotive and ten cars; and
4. An F59PH locomotive and ten cars.

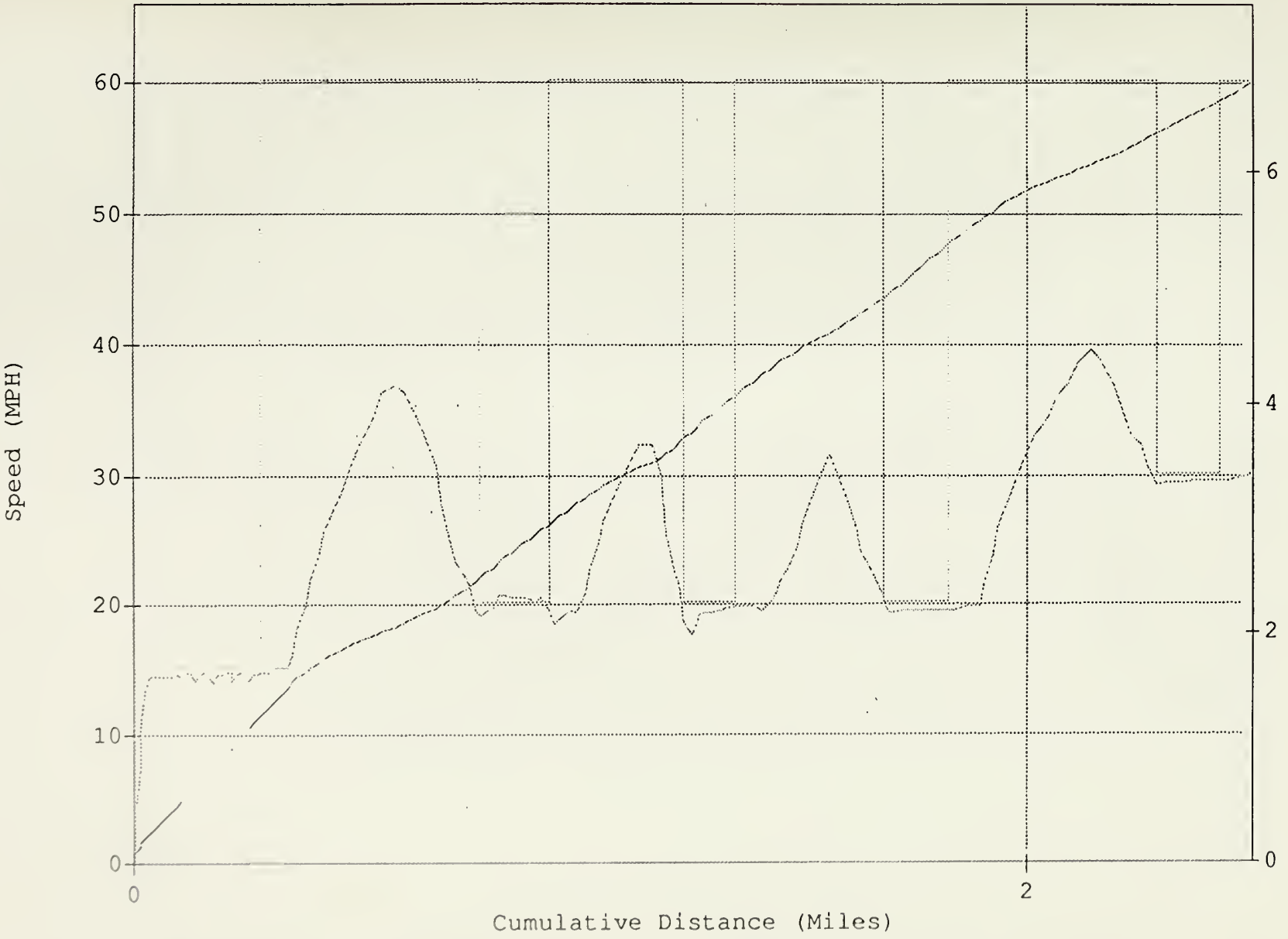
Because the electric motors of the locomotive would be powered by the electric power pack trailer in the tunnel, the fuel consumption figures on the graphs are only relative indications of the power consumed by the train.

Each configuration is analyzed for both inbound and outbound directions. Two alignment options are analyzed, for a total of sixteen graphs. The two alignment options are:

1. The base alignment (labeled "original proposal" on the graphs) with primarily 20-mph curves at critical points, and

2. An alignment options with a long, 50-mph curve at the critical point on the downtown extension.

F-40 with four cars



Total Time: 6.8 Minutes
Total Fuel: 10.0 Gallons

Total Distance: 2.5 Miles
Average Speed: 22.2 MPH

CSI
CORPORATE STRATEGIES, INC.

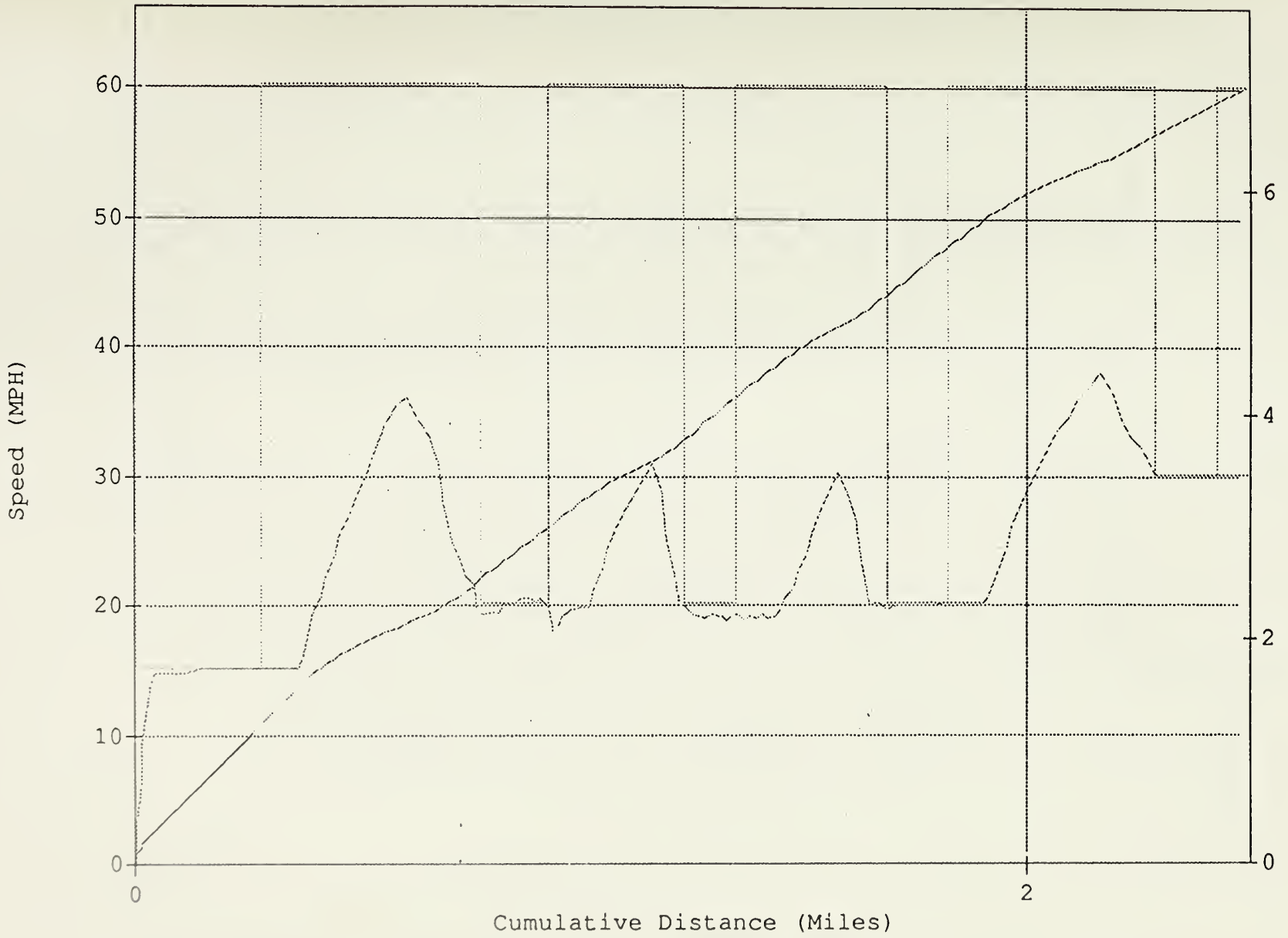
ORIGINAL PROPOSED ALIGNMENT AND SPEEDS
OUTBOUND

F-40 with four cars

ORIGINAL PROPOSED ALIGNMENT AND SPEEDS
INBOUND

Total Time:	6.8 Minutes	Total Distance:	2.5 Miles
Total Fuel:	9.0 Gallons	Average Speed:	22.1 MPH

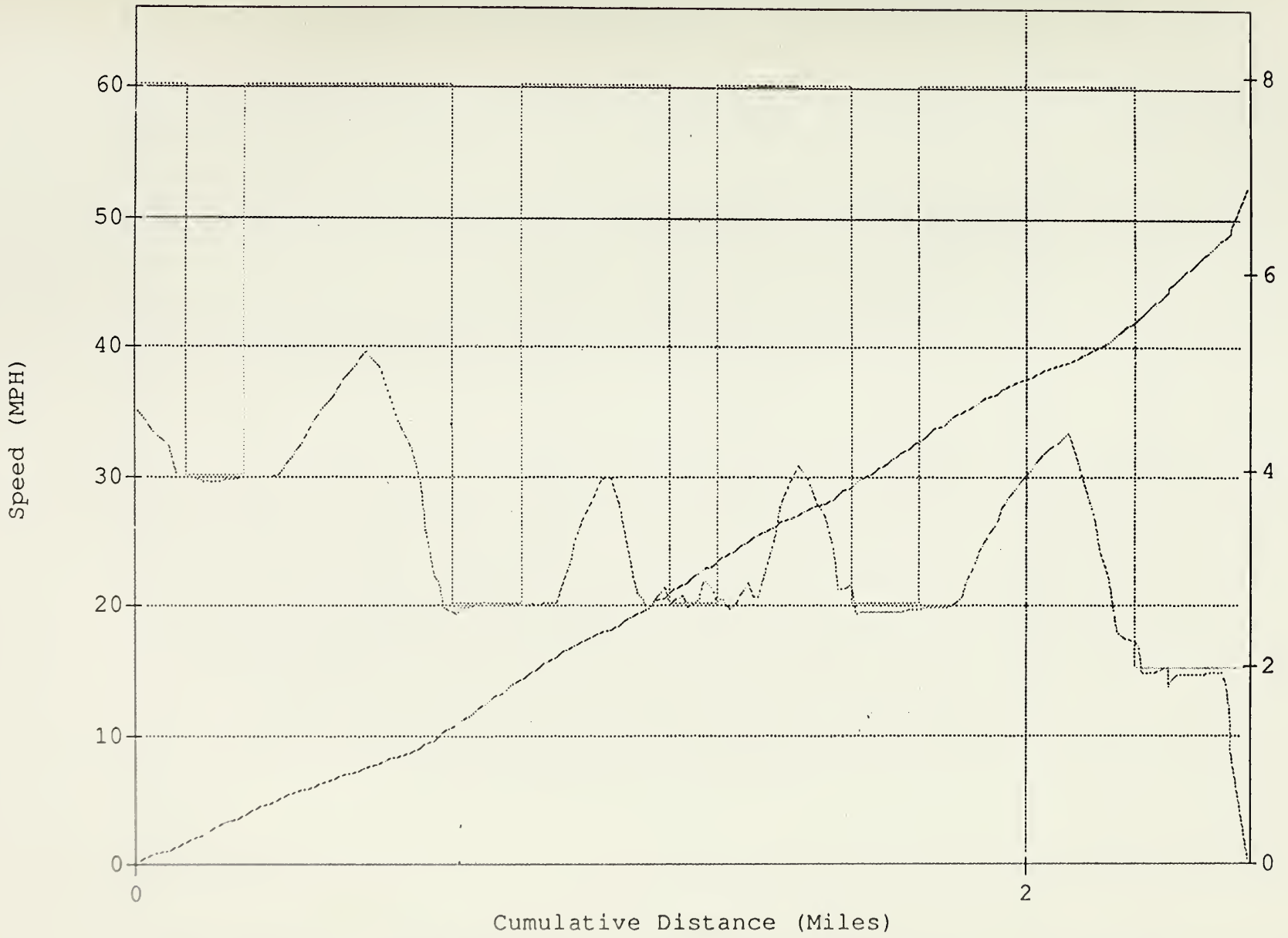
F-40 with five cars



ORIGINAL PROPOSED ALIGNMENT AND SPEEDS
OUTBOUND

Total Time:	6.9 Minutes	Total Distance:	2.5 Miles
Total Fuel:	11.0 Gallons	Average Speed:	21.7 MPH

F-40 with five cars

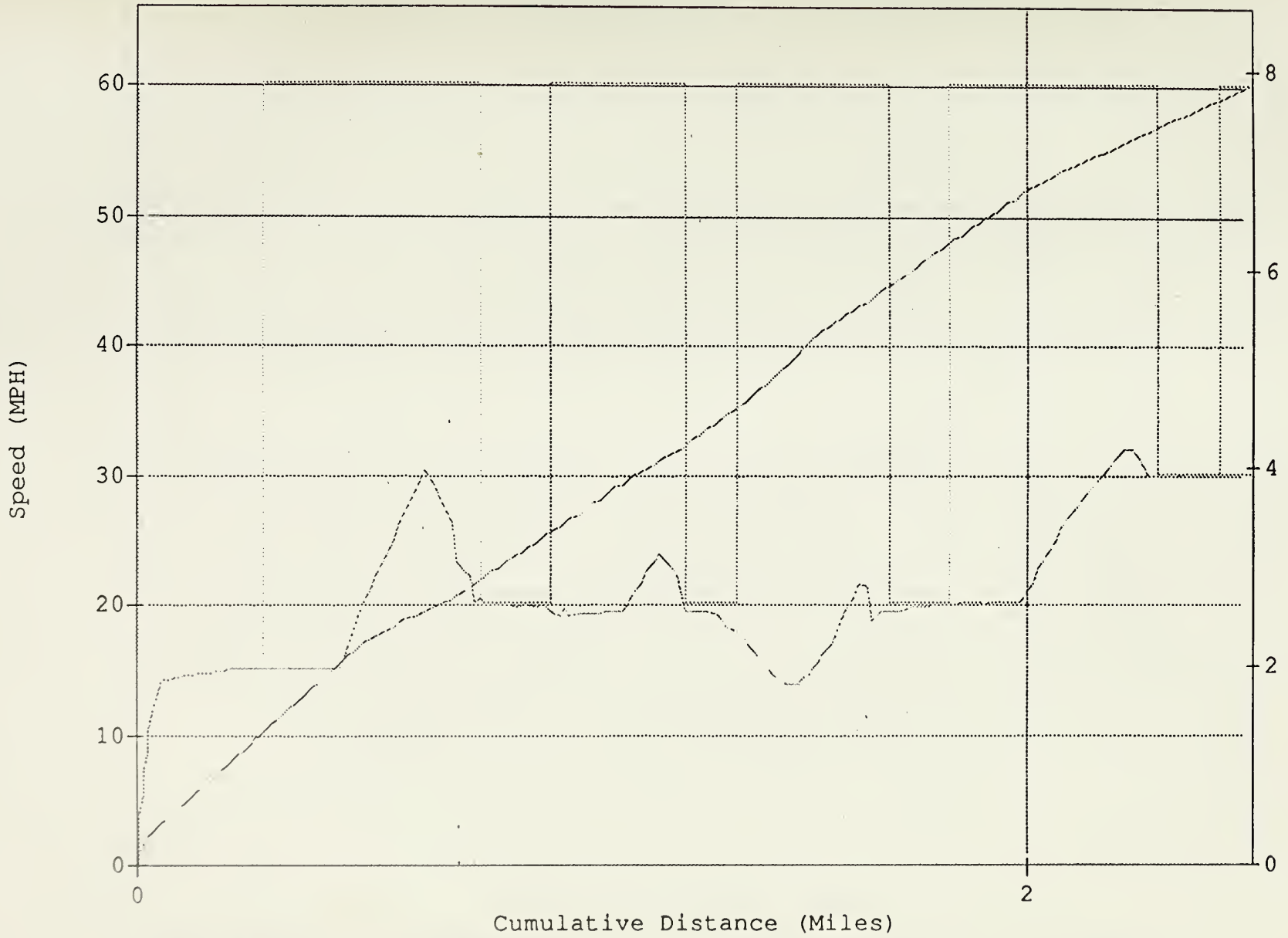


ORIGINAL PROPOSED ALIGNMENT AND SPEEDS

INBOUND

Total Time:	6.9 Minutes	Total Distance:	2.5 Miles
Total Fuel:	9.0 Gallons	Average Speed:	21.8 MPH

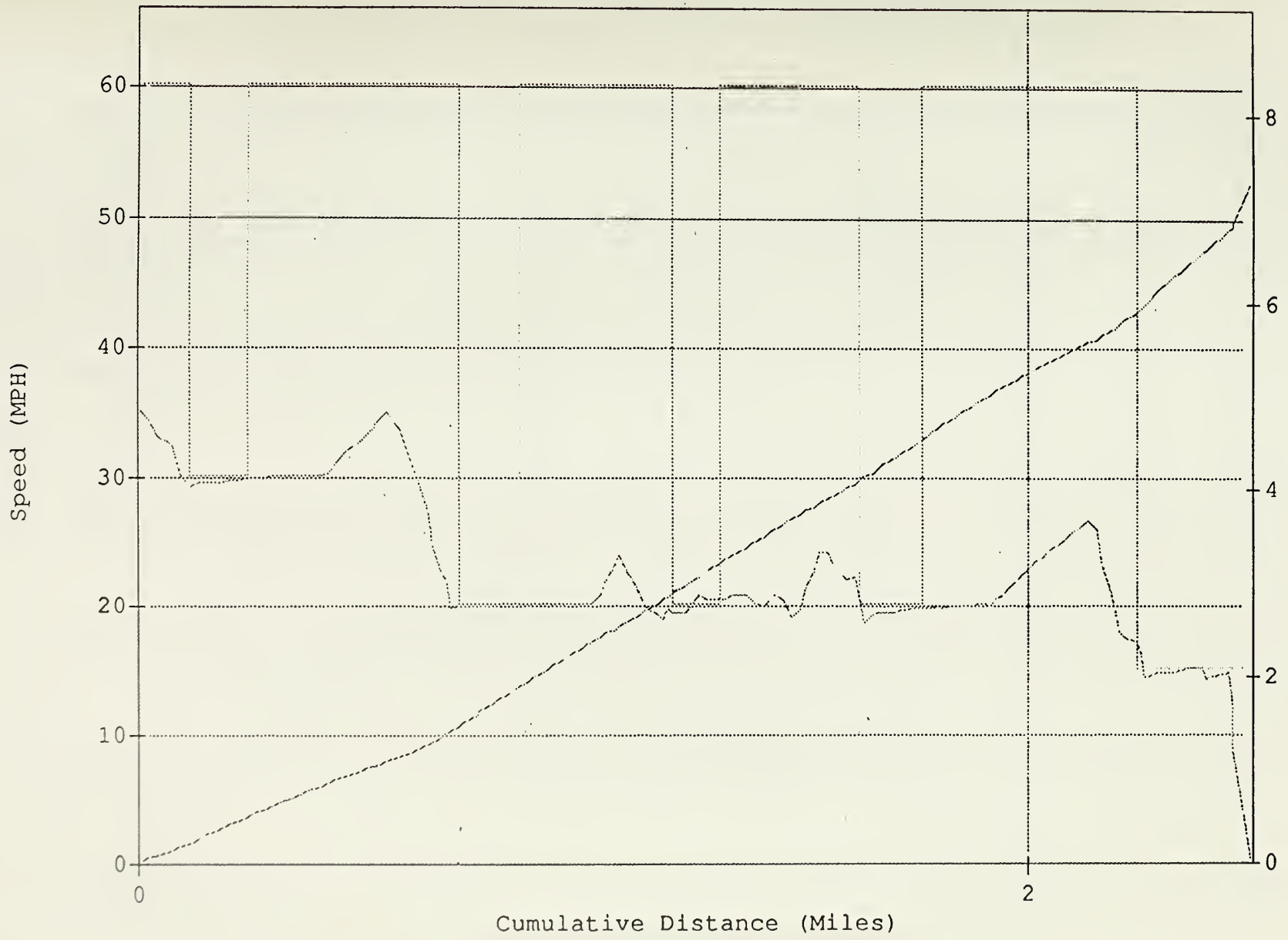
F40 with 10 California Cars



ORIGINAL PROPOSED ALIGNMENT AND SPEEDS
OUTBOUND

Total Time:	7.8 Minutes	Total Distance:	2.5 Miles
Total Fuel:	14.0 Gallons	Average Speed:	19.2 MPH

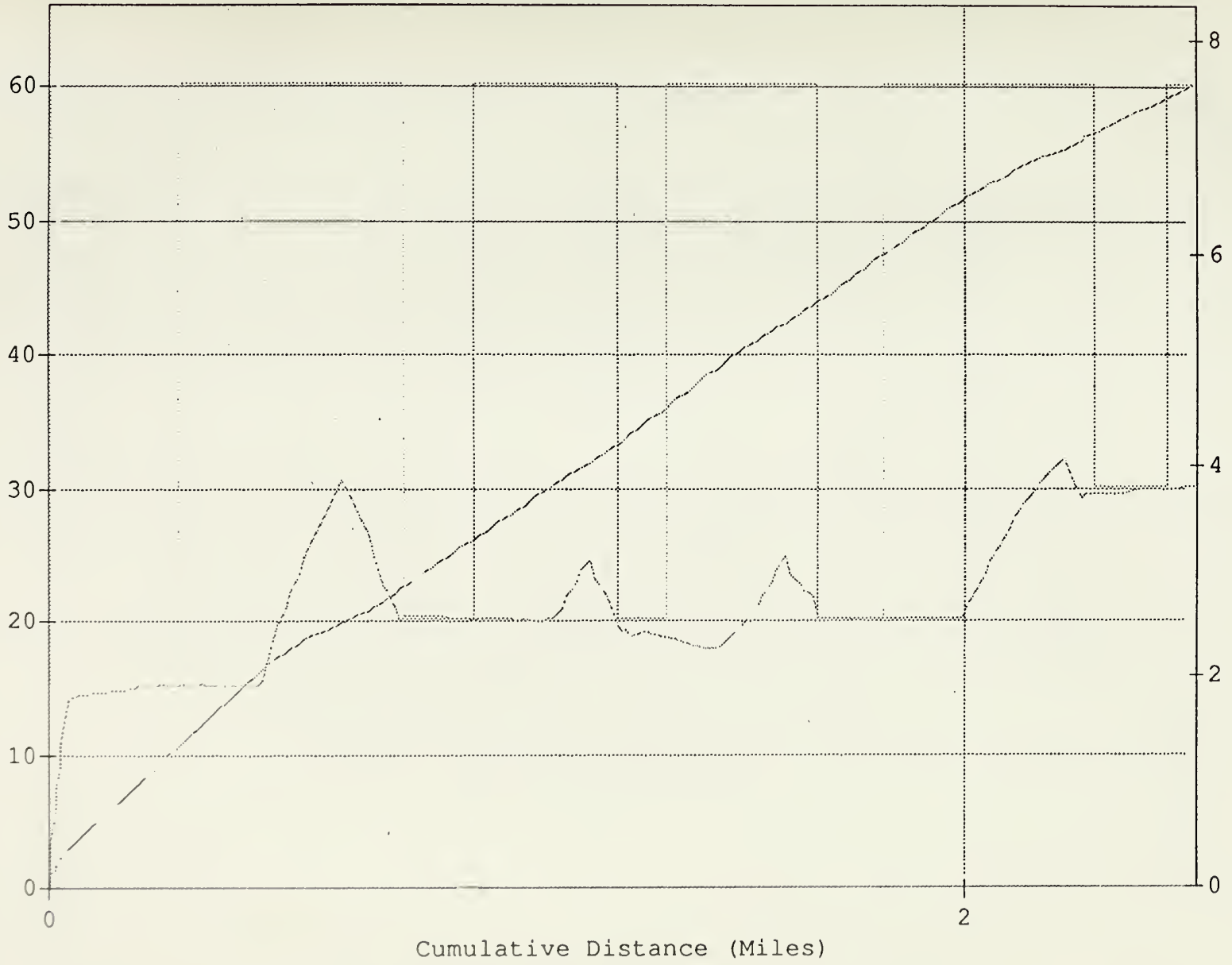
F40 with 10 California Cars



ORIGINAL PROPOSED ALIGNMENT AND SPEEDS
INBOUND

Total Time:	7.3 Minutes	Total Distance:	2.5 Miles
Total Fuel:	9.0 Gallons	Average Speed:	20.6 MPH

F59PHI with 10 California Cars



Total Time: 7.6 Minutes
Total Fuel: 8.0 Gallons

Total Distance: 2.5 Miles
Average Speed: 19.8 MPH

CSi
CORPORATE STRATEGIES, INC.

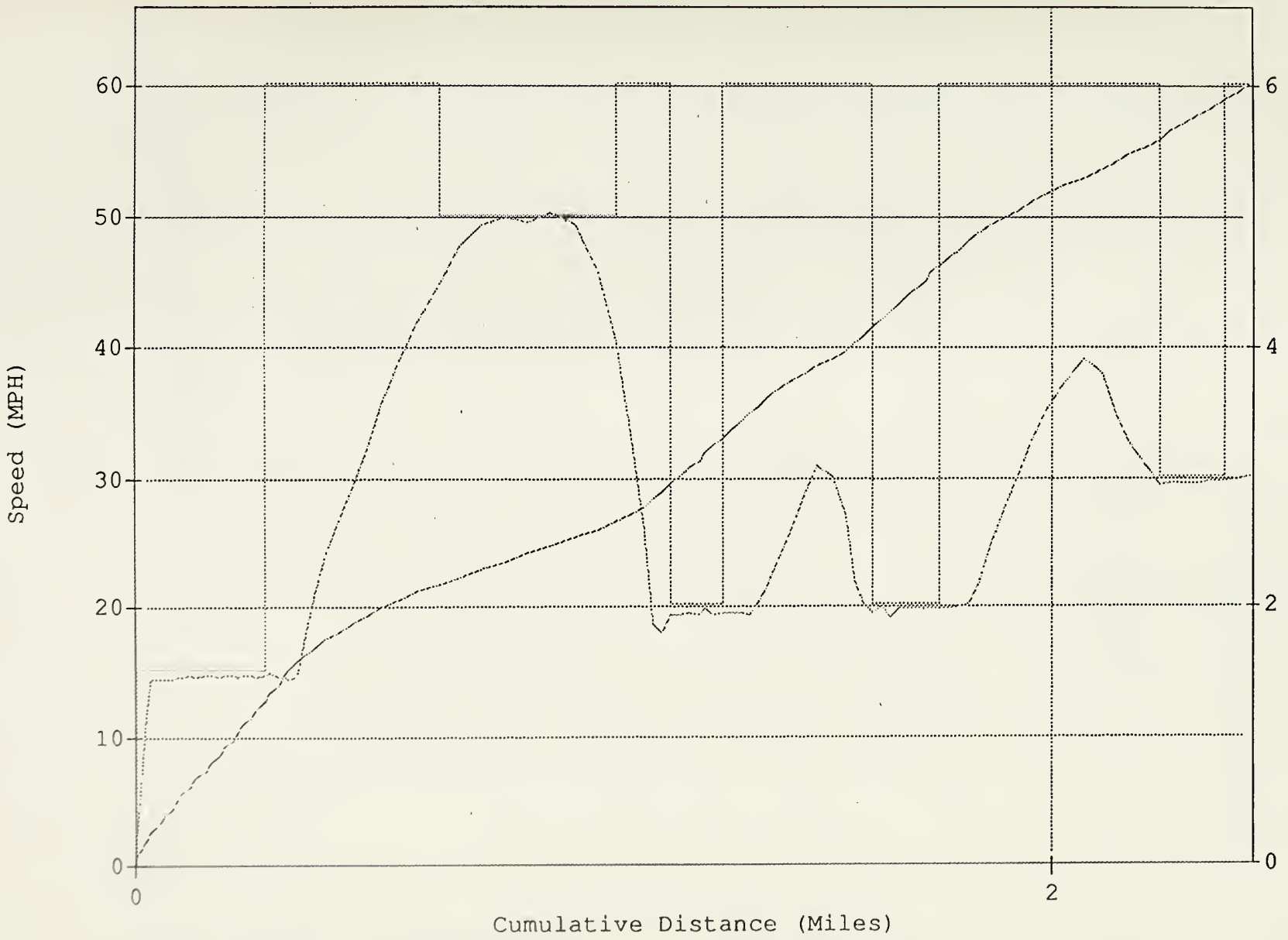
ORIGINAL PROPOSED ALIGNMENT AND SPEEDS
OUTBOUND

csi
CORPORATE STRATEGIES, INC.

ORIGINAL PROPOSED ALIGNMENT AND SPEEDS

INBOUND

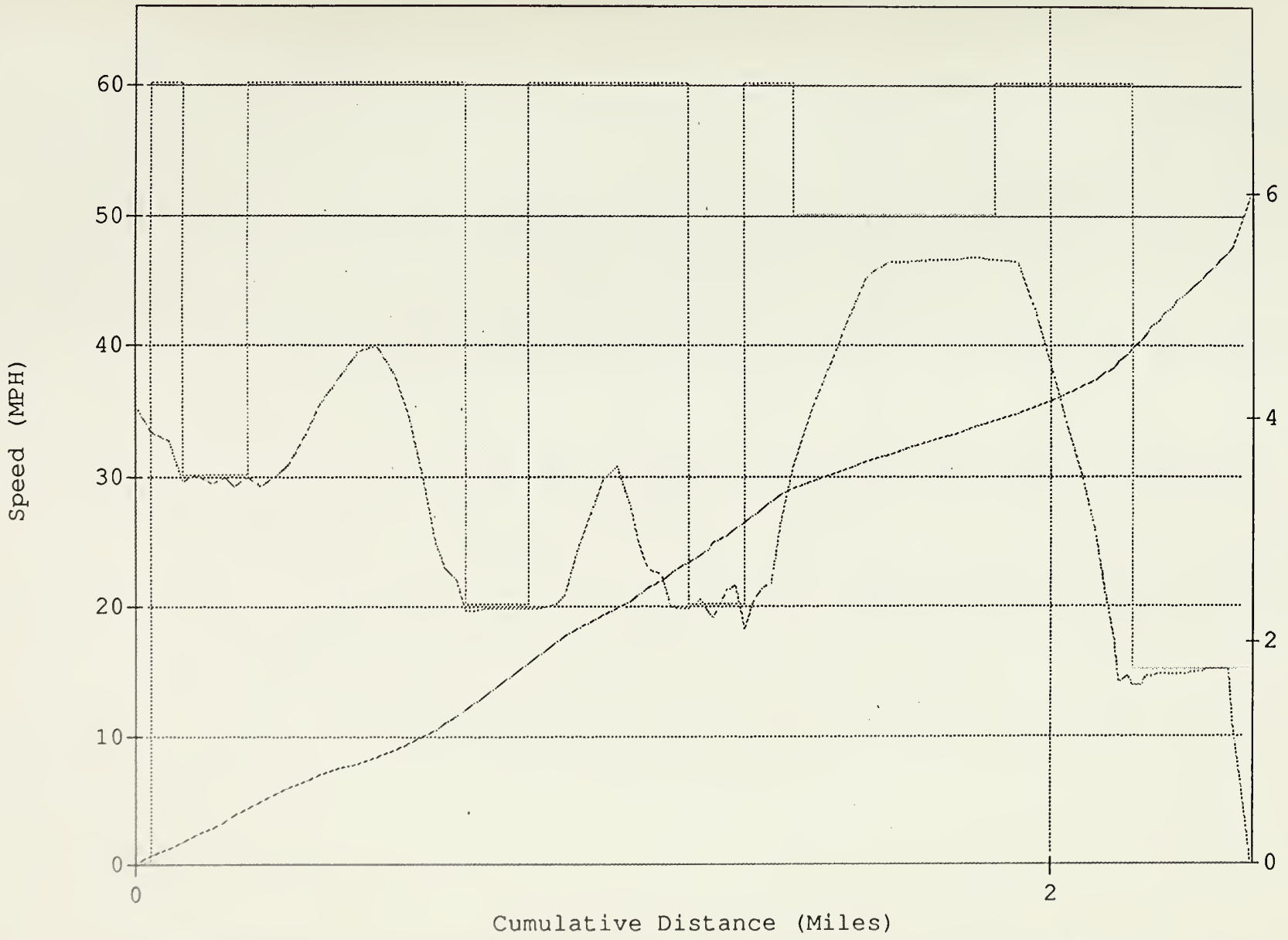
F-40 with four cars



LONG CURVE PROPOSED ALIGNMENT AND SPEEDS
OUTBOUND

Total Time:	6.0 Minutes	Total Distance:	2.4 Miles
Total Fuel:	10.0 Gallons	Average Speed:	24.3 MPH

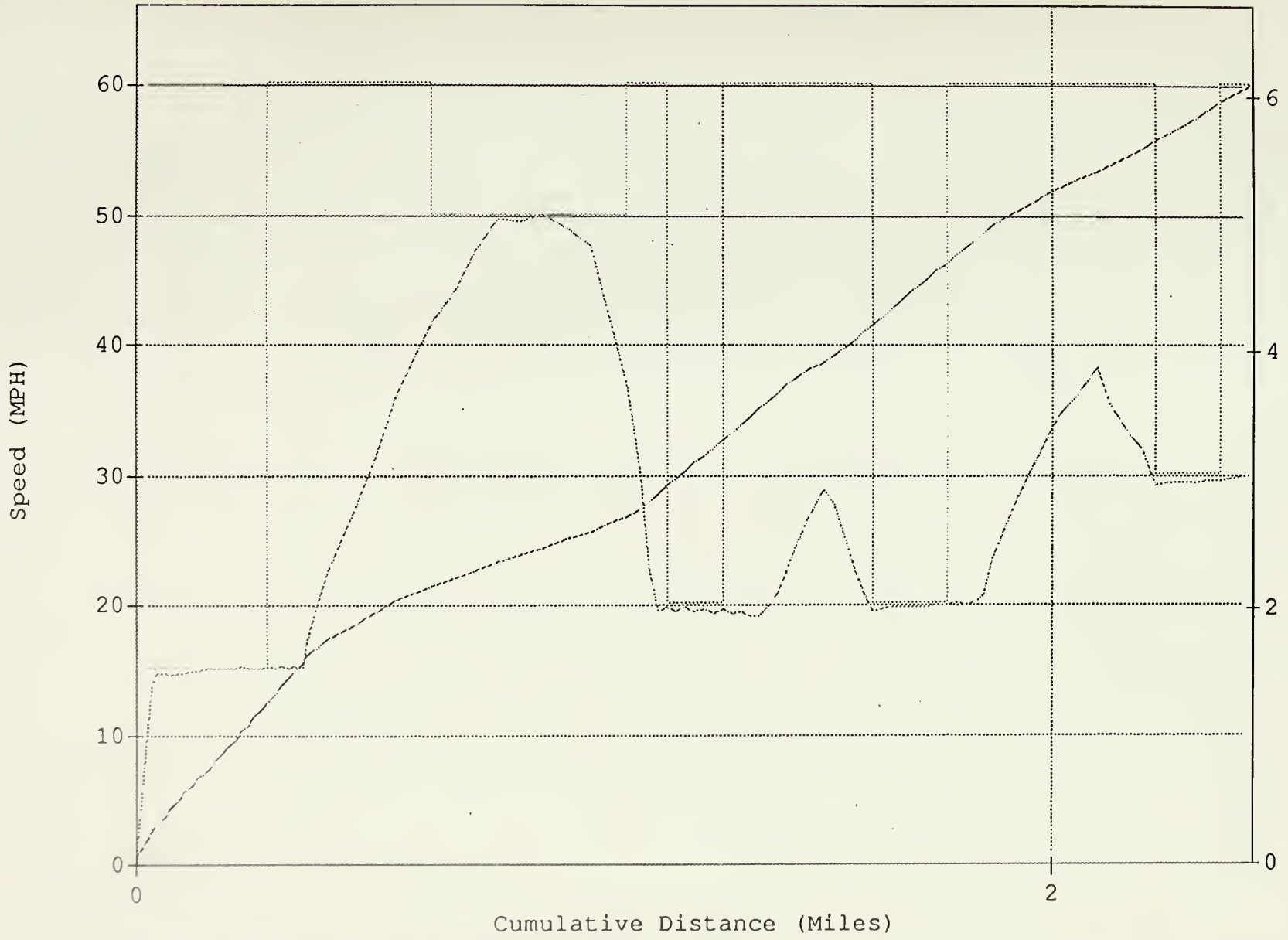
F-40 with four cars



LONG CURVE PROPOSED ALIGNMENT AND SPEEDS
INBOUND

Total Time:	6.0 Minutes	Total Distance:	2.4 Miles
Total Fuel:	8.0 Gallons	Average Speed:	24.4 MPH

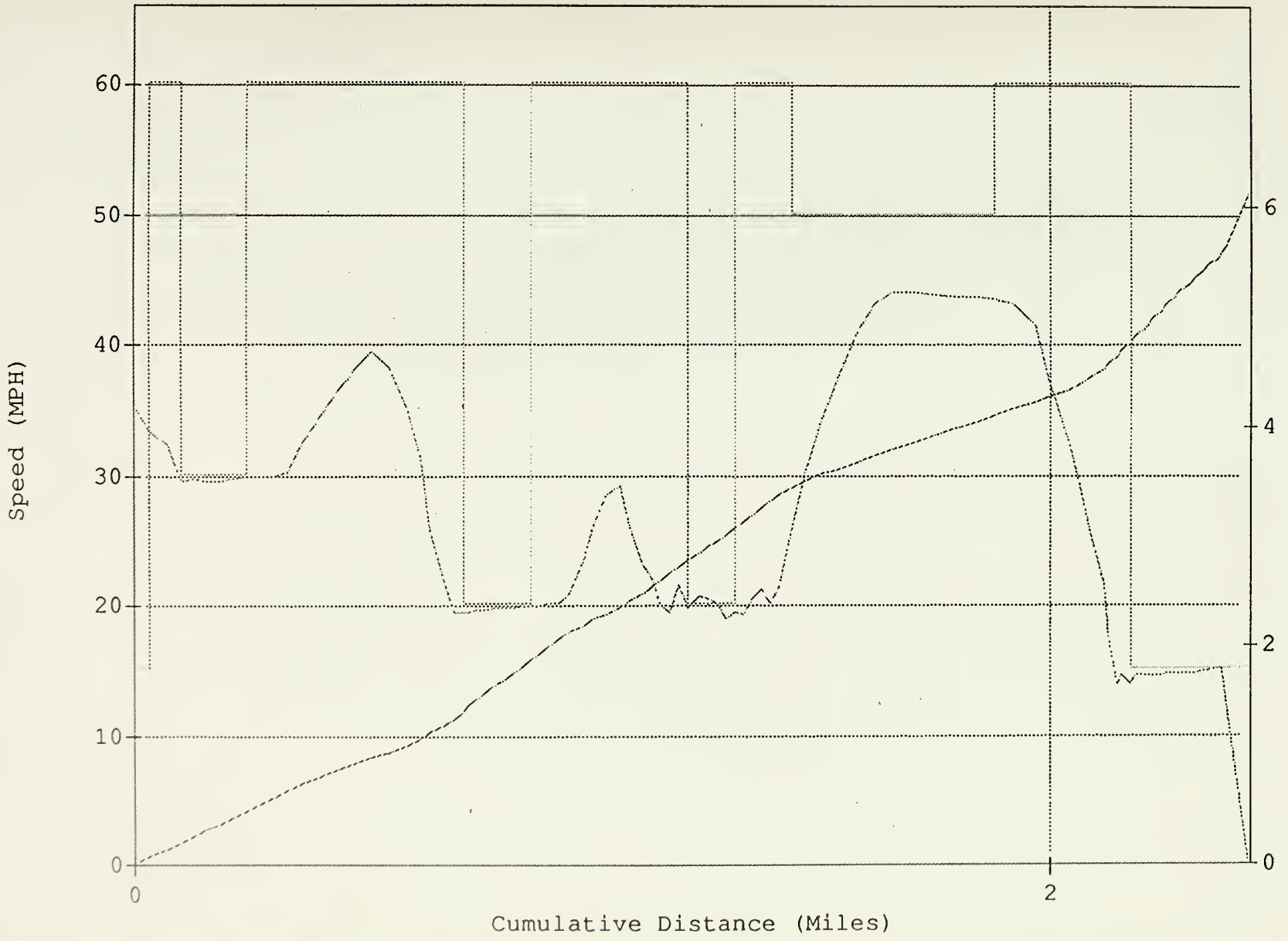
F-40 with five cars



LONG CURVE PROPOSED ALIGNMENT AND SPEEDS
OUTBOUND

Total Time:	6.1 Minutes	Total Distance:	2.4 Miles
Total Fuel:	10.0 Gallons	Average Speed:	24.0 MPH

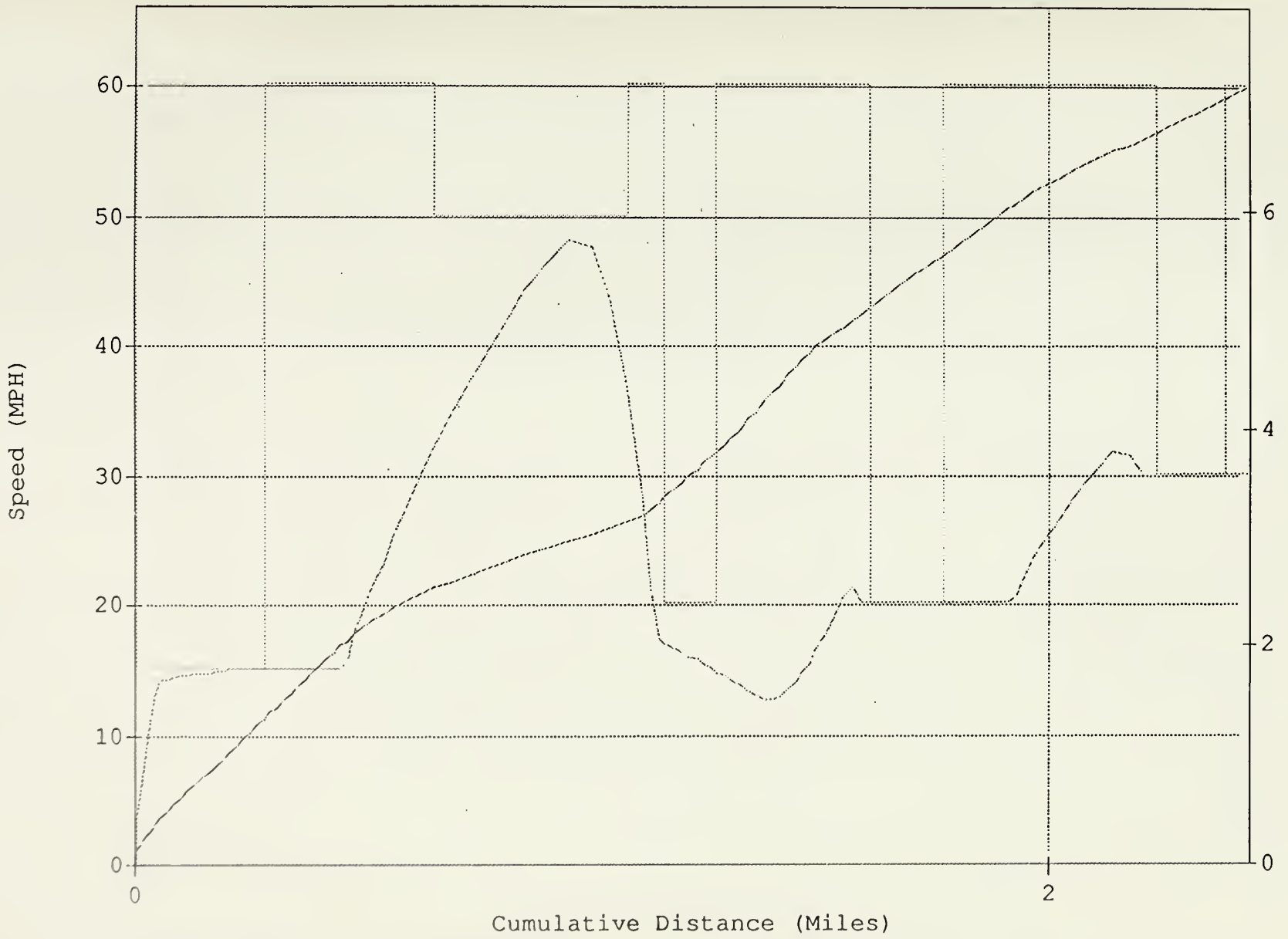
F-40 with five cars



LONG CURVE PROPOSED ALIGNMENT AND SPEEDS
INBOUND

Total Time:	6.1 Minutes	Total Distance:	2.4 Miles
Total Fuel:	8.0 Gallons	Average Speed:	23.9 MPH

F40 with 10 California Cars



LONG CURVE PROPOSED ALIGNMENT AND SPEEDS
OUTBOUND

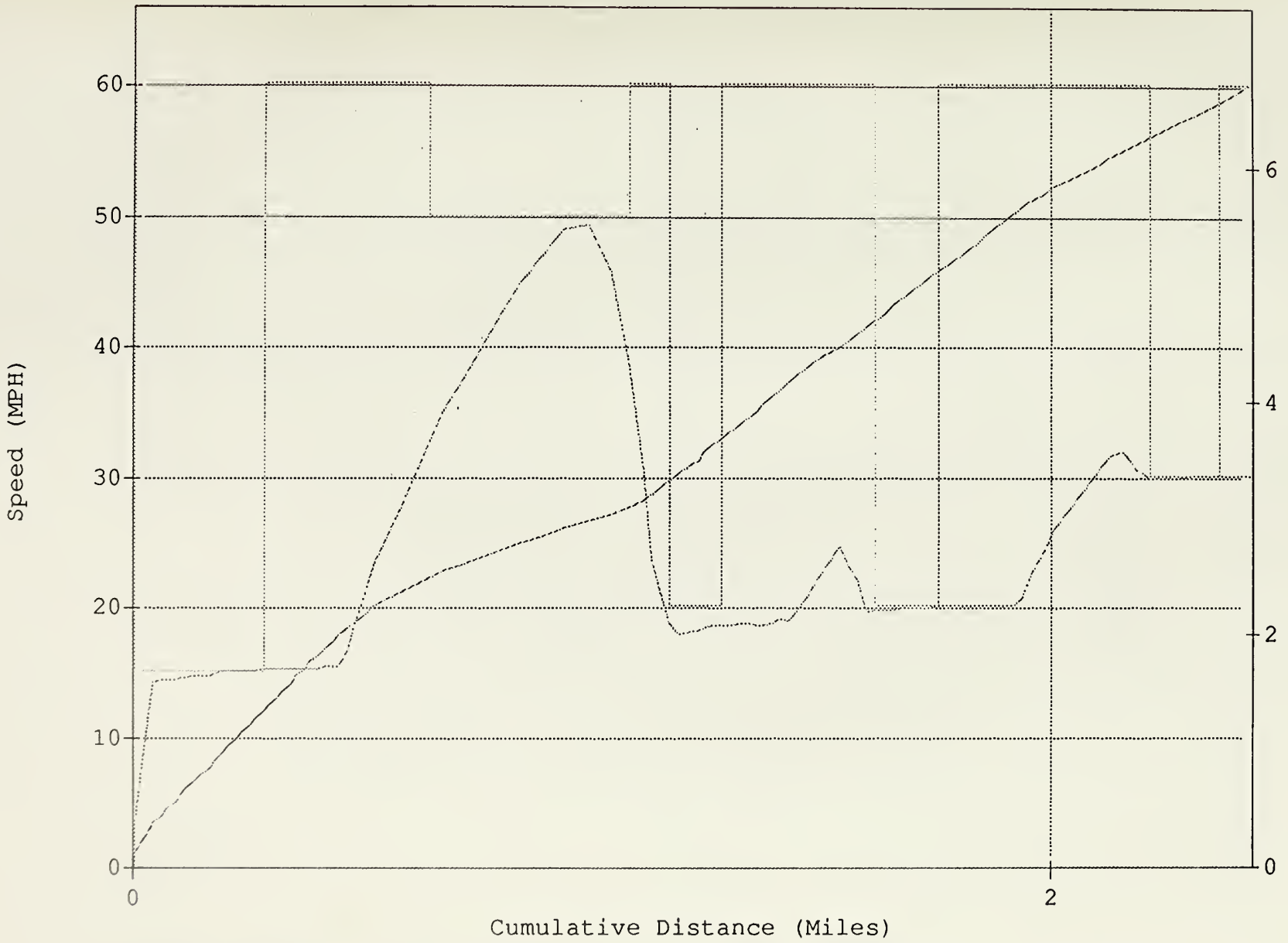
Total Time:	7.1 Minutes	Total Distance:	2.4 Miles
Total Fuel:	13.0 Gallons	Average Speed:	20.4 MPH

F40 with 10 California Cars

LONG CURVE PROPOSED ALIGNMENT AND SPEEDS
INBOUND

Total Time:	6.5 Minutes	Total Distance:	2.4 Miles
Total Fuel:	9.0 Gallons	Average Speed:	22.5 MPH

F59PHI with 10 California Cars



LONG CURVE PROPOSED ALIGNMENT AND SPEEDS
OUTBOUND

Total Time:	6.7 Minutes	Total Distance:	2.4 Miles
Total Fuel:	8.0 Gallons	Average Speed:	21.8 MPH

F59PHI with 10 California Cars

LONG CURVE PROPOSED ALIGNMENT AND SPEEDS
INBOUND

Total Time:	6.5 Minutes	Total Distance:	2.4 Miles
Total Fuel:	5.0 Gallons	Average Speed:	22.5 MPH